PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, MARCH 31st, 1920.

The Forty-fifth Annual General Meeting, together with the Ordinary Monthly Meeting was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, March 31st, 1920.

ANNUAL GENERAL MEETING.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

The Minutes of the preceding Annual General Meeting (March 26th, 1919) were read and confirmed.

PRESIDENTIAL ADDRESS.

(Plates i.-viii.)

Once again, after five years, we hold our Annual Meeting under the ægis of Peace. The interval since our last Annual gathering has been a very eventful period, a year crowded with stirring events. This has been due in part to the fact that so many of them have brought reminders of the "eternal verities" in their train. First of all, we have had the Proclamation, and then the Ratification of Peace, and the prospect of a League of Nations. But the War ended by armistice and not by surrender, and the Peace which followed was a peace by negotiation and not a peace after surrender; and so many nations had been drawn into the War, that the problems for consideration and settlement were so numerous and so difficult, that the preliminaries were protracted, and sometimes lacked unanimity. Now the war has ended, the return to a peace-footing has not come about quite so soon, or in quite the same way as perhaps was expected, so profoundly have world-affairs become involved, and been upset. For example, the belief that high prices for food and clothing would come down when the war-purchases ceased, has not been realised.

Not less eventful or moving to us has been our witness of the epilogue of the story, which began "Australia *will* be there": then, in due time attained the clearer note, "Australia *was* there"; and then the epilogue "Australia *is* here again"—but not all, by about 60,000. This story has been a telling illustration of what the enemy quite failed to realise, namely, how great moral issues could stir and unite free democracies in a great crisis. The return of Anzacs and Diggers, as well as of those who whole-heartedly co-operated with them in all sorts of capacities, and of the men of the Australian Navy, has demonstrated to us the characteristic modesty of the modest man, who, thrice armed because the quarrel into which he was drawn was just, then did his bit, and played the game, but is loth to talk about his deeds. We are glad to know that the repatriation and demobilisation of the Australian troops has been almost completed; and that the problem of their return to civil life is receiving the attention and consideration which it deserves.

One of the most moving events of the year was the simple but very effective ceremony observed, by the wish of His Majesty, on the eleventh day of the eleventh month, at the eleventh hour, when, standing with uncovered heads, all business suspended and traffic stopped, our hearts took charge of us, and we paid our silent and sincere homage to the memory of the honoured and mighty Dead, who, though dead, yet speak to very many. I think we all hope that the observance of this simple and touching ceremony, "the King's Great Silence," as it has been aptly termed, so appealing in its directness and in its naturalness, will become an annual fixture; and that, in unison, we shall continue to hold these real and legitimate stop-work Meetings, not only "Lest we forget," but also to show that we have not forgotten.

Another stirring event in the early part of the year, not without its lessons, was a severe epidemic of influenza of a virulent type, which, as in other countries, not only upset, from top to bottom, the home-life, the educational life, the business-life, the industrial life, and every other grade of our community life, but brought bereavement to many households and aggregates. Nevertheless, the blackness of the calamitous cloud, which overshadowed us for so long, was not without some silver streaks of lining, in the shape of the unselfishness and self-sacrifice, heroic as often as circumstances required, on the part of doctors, nurses, and volunteers of both sexes, intent on doing their utmost, at all risks, for the relief of the prostrated and the helpless, and the succour and comfort of the bereaved.

Another great event was the memorable visit of the Triumphant Four, regardless of Father Neptune's approval, descending upon Australia like a "bolt from the blue." It was a great achievement, which justly evoked appreciative words and deeds. But have we, as a community, appreciated the real significance, and the inner meaning of this much-needed object lesson? Sir Ross Smith did not tell us how many strikes there were on the aerial voyage; or how the mechanics held a stop-work meeting aloft, and said—"Our mates produced this machine; therefore, we are entitled to all the products of this stunt. If you don't concede that, we will hitch the wagon to a star, and go on strike." Of course, we know why Sir Ross Smith did not mention the subject of strikes. So having shown very great enthusiasm and appreciation over a very successful enterprise, because the organisation, co-operation, co-ordination, concentration, single-mindedness, unity of purpose, were about as perfect, and as perfectly provided for as they could be, in a very limited space, under very strenuous and exacting conditions, waste of every kind, including energy potential and otherwise, eliminated, and friction reduced to a minimum—what more did the sequel amount to than *revenons à nos moutons*, strikes, discord, ebullitions of accentuated, vituperative party-feeling on the eve of two elections, &c., &c. "Man is a scholar eager indeed to learn, but most forgetful having learned."

Other events that have come home to us by the experience of a shortage of bread, or a shortage of sugar, and the interruption of communications with the distant States or New Zealand, or in some other way, are the numerous Strikes which have interfered with what we are accustomed to call our normal, every-day social and business-life and activities. Fortunately the meeting of the Australasian Association for the Advancement of Science was due next year, and not this, or it must have lapsed.

We have also had the disturbing experiences of a Federal Election and a State Election, both carried out with a great deal of friction, and personal as well as party-bitterness and recrimination.

June 13th, ensuing, will be the centenary of the birth of the Society's benefactor, Sir William Macleay. The Council is arranging for a Special Meeting, to be held on June 14th, the actual day of the anniversary being Sunday this year. Further particulars will be furnished to Members in the Abstract of Proceedings after the Meeting to be held on 26th May.

Since the last Annual Meeting, more of our Soldier-Members, or Members who volunteered for war-work abroad, have returned to Australia; and we have had the pleasure of personally welcoming some of them at one or other of our Meetings. We are now able to compile a complete list of those who have served the Nation or the Commonwealth abroad, in some capacity or other as follows:—

ACTIVE SERVICE.

Aurousseau, M., M.C.	Ferguson, E. W.	Laseron, C. F.
Badham, C.	*Fry, D. B.	North, D. S.
Bickford, E. I.	Goldfinch, G. M.	Oliver, W. R. B.
Bretnall, R. W.	Hamblin, C. O.	*Stephens, H.
Broom, Prof. R.	Harrison, L. M.	Stokes, E. S.
Carne, W. M.	Henry, M.	
David, Prof. T. W. E., D.S.O.	Kenny, F. H.	

* Killed in action.

MUNITION WORK, ETC.

Griffiths, E.	Mawson, Sir D.	Tilley, C. E.

A special Honour Roll is in contemplation, of such a character that coloured copies of it can be prepared for insertion in the Parts of the Proceedings, so that every Member may have one, especially those Members who live at a distance. It is proposed that the original shall be displayed in a conspicuous place in the Hall; and that it shall be formally unveiled in a becoming manner, as part of the programme of the Special Meeting for the celebration of the William Macleay Centenary, on June 14th. It is to be a permanent, memorial record of the names of those Members of the Society, who represent, to the rest of us, the great aggregate of comrades who successfully strove to save the rest of the world from Might as against Right. The Council thinks that Members would like to have a direct, personal interest in this appropriate memorial; and it accordingly invites us to contribute, according to our means, a share of the cost of providing it, as a tribute to the great aggregate which our Soldier-Members represent, as well as to them collectively. I commend the proposal to your favourable consideration.

The concluding Part of Volume xliv., of the Society's Proceedings was issued on the 15th instant. The complete volume (912 and xxxii. pp., 47 Plates, and 212 Text-figures) contains thirty-four papers, ten of which were contributed by members of the Society's research staff. These cover a representative series of the subjects in which the Society is directly interested.

Our exchange-relations with Societies and Institutions outside the Commonwealth have begun to show gratifying signs of recovery. The Bureau of International Exchanges at Washington has been able to resume its despatches to this part of the world, after suspension brought about by war-conditions; and this means a great deal to the Society. Postal communications have improved somewhat, though still not altogether normal. Consequently, Scientific Societies in neutral and other countries are seeking to fulfil the obligations which were interfered with by abnormal conditions. But it affords me very special pleasure and satisfaction to be able to announce, that, after the turmoil of war, five out of the seven Belgian Scientific Societies with which we have exchanged publications for so many years, and from whom we were so abruptly cut off in 1914, have succeeded in getting into touch with us again. These are l'Academie Royale des Sciences des Lettres et des Beaux-Arts de Belgique, Societe Entomologique de Belgique, Societe Geologique de Belgique, Societe Royal de Botanique de Belgique, and Societe Royal Zoologique et Malacologique de Belgique. I gladly avail myself of this opportunity of offering to them the Society's cordial greetings on the resumption of their scientific activities, its sympathy with them in the anxieties and trials which they have endured, as well as any help that we can give, if it be necessary. The total number of exchanges received during the Session 1918-19 amounts to 799 additions to the library, received from 132 Societies, Institutions, &c., and ten private donors, as compared with 687, 846, 1243, 1028, and 1285 for the five preceding Sessions. Effort has been made, on the Society's part, to bring its despatches as far as possible up to date.

Six Ordinary Members were elected, five have resigned during the year; we have lost one of our older members by death; and, in addition, news came to us of the decease of one of our soldier-members some time ago.

Harry Stephens, like Dene Fry, was a very promising young biologist, whose career ended prematurely amid the havoc of battle. After leaving school, he entered the Department of Agriculture as a cadet; later on he took the degree of B.Sc., in Agriculture; and was subsequently appointed to a Walter and Eliza Hall Agricultural Fellowship with the object of doing research-work upon Cereal Rusts. He had made some progress in this work, when war was declared, and he enlisted for active service in 1915. He left for the front, as Second Lieutenant, in February, 1916, and spent some time in Egypt. Thence he proceeded to Salisbury, where he was promoted to First Lieutenant; later, he accompanied his battalion to France, where, in May, 1917, he became Captain. On the night of 18th November, 1917, three weeks after his twenty-seventh birthday, he had just entered the trench to which he was allotted, when he was killed instantaneously by a bursting shell. Captain Stephens was elected a Member in 1915, but, in consequence of the pressure of his University and other work, we never had the pleasure of welcoming him to our Meetings. Professor Watt, with whom he had most to do at the University, as well as Mr. Maiden, speak of him in the highest terms as possessing in a marked degree the qualities which go to make a successful investigator, as well as a keen sense of honour and of duty. His University course was highly creditable, as he gained the Belmore Scholarship for Chemistry and Geology in his first year, and Mr. Maiden's prize for Agricultural Botany; and first class honours and a University medal at graduation. Biological research in Australia has suffered a great loss by the untimely deaths of the only two of our Soldier-Members who have not returned to us.

William Joseph Rainbow, elected a Member in 1893, migrated from England to New Zealand in 1873, and ten years later came to Sydney. While engaged in journalistic work, he became enthusiastically interested in natural history; and, in 1895, he was appointed entomologist to the Australian Museum, and continued to hold that position until his death on 21st November, 1919. He was especially interested in the *Araneidae;* and his numerous contributions to a knowledge of this and other groups, include seventeen papers in the Society's Proceedings for the years 1892-1902; and others in the Records of the Australian Museum, and in the "Australian Naturalist." He was also the author of two useful additions to our popular science manuals, namely "A Guide to the Study of Butterflies." and "Mosquitoes: their Habits and Distribution." Mr. Rainbow was personally known to many of us as a kindly, earnest, upright man, very keenly interested in his work, and very desirous of helping others to realise the attractiveness and the interest of the wonderful Australian fauna. One of his sons enlisted soon after the outbreak of war, and was killed at the Dardanelles on May 24th, 1915. This sorrowful event hastened the death of his wife soon afterwards. Another son also enlisted, and returned a few days after his father's decease.

Recent events have brought about some changes directly or indirectly affecting the scientific life of the community. Their decease has deprived it of two of our scientific veterans—Sir Thomas Anderson Stuart, Professor of Physiology in the University of Sydney; and Robert Etheridge, Junr., Director and Curator of the Australian Museum, both, at one time, Members of this Society, and the latter, for some years, a Member of Council.

Several of our Members have retired from active work after putting up long records of faithful and productive service.

Professor Anderson Stuart, Dean of the Faculty of Medicine of the University of Sydney, and Chairman of Directors of the Royal Prince Alfred Hospital, has been a very prominent figure in the educational and public life of the State ever since his arrival in 1883. The development of the Medical School and its growing influence as a factor in medical education, afford abundant testimony to his organising capacity and his forceful character. His death, on February 29th, 1920, at the age of 64, closes an impressive chapter of personal history, as well as a very important stage in University history on the medical side.

Robert Etheridge, Junr., was, I think, the oldest scientific worker in harness in Australia. His first contribution to scientific knowledge, a geological quarter-sheet map of the Yan Yean district of Victoria (2 N.E.), embodying the results of his field-work during the preceding year, was published in 1869. His last, the second of two papers on the early history of the Australian Museum, was issued on 4th December, 1919, about a month before his decease; so that his published work covers a period of fully fifty years. He was the son of Robert Etheridge, Senr., to whom there is a very interesting reference in Geikie's "Life of Sir Roderick Murchison" (1875) (Vol. ii., p. 259) to this effect—"Early in July, 1856, Murchison betook himself into Gloucestershire to see some of his old Silurian haunts. Mr. Ramsay joined him, and some time was spent by them among the Silurian and Oolitic rocks of the Tortworth district, where they enjoyed the hospitality of Lord Ducie, who accompanied them in their excursions." . . . "Among the Cotteswold hills," Murchison records in his journal, "we made various excursions in the range of the Lower Oolites, and were accompanied by a very intelligent person who had been in business in Cheltenham, and had quitted it for the hammer. This was Robert Etheridge. Judging from his celerity, his quickness in finding shells and naming them, and in drawing sections, I said to Ramsay 'This is the man we must have to put our Jermyn Street Museum in order.'" Geikie adds, in a footnote,—"Mr. Etheridge, whose merits were already known to Lord Ducie, had been asked by his Lordship to meet the geologists at Tortworth. He was soon after appointed Assistant Naturalist to the Geological Survey; subsequently, on the resignation of Mr. Salter, he became Palæontologist, and since that time has gradually risen to hold a foremost place among the palæontologists of this country." Robert Etheridge, Junr., was a boy about nine years old at this time; and he seems to have inherited his father's interest in geology, and especially in palæontology; for, about 1868, as field-geologist, he joined the staff of the Geological Survey of Victoria, so ably organised in 1852 and conducted for seventeen years by Dr. Alfred Selwyn, with the co-operation of men like Richard Daintree, C. S. Wilkinson, C. D'Oyley H. Aplin, H. Y. L. Brown, and others, who not only left their mark on the records of Victorian geology, but subsequently occupied important official positions in Queensland, New South Wales, South Australia, or elsewhere in the Commonwealth, or in New Zealand. R. Etheridge, Junr., on severing his connection with the Geological Survey of Victoria, became palæontologist to the Geological Survey of Scotland, and afterwards senior assistant in the Geological Department of the British Museum. In 1887, he came back to Australia to fill the position of palæontologist to the Geological Survey of New South Wales and to the Australian Museum, of which, in 1895, he became Curator, and later on Director. The list of his contributions to scientific knowledge, and especially those relating to the palæontology and anthropology of Australia is very voluminous and valuable. Thirty-six of his papers, together with six joint papers, are to be found in the Society's Proceedings for the years 1888-1915, together with one in the Macleay Memorial Volume. One needs to be a palæontologist to appreciate the merits of his long-sustained work; but I think that it may be said of him, that he did very much for Australian palæontology, what his father did for British palæontology. But over and above this, in connection with the Australian Museum, he has left a good record as an able organiser and director. His labours ended on January 5th, 1920, in his seventy-third year, while he was away for a holiday at Mittagong. We may hope for a more extended biography written by one who was a colleague, and had a direct interest in his work.

The untimely death of Dr. F. M. Gellatly, Director of the Commonwealth Institute of Science and Industry, at the early age of 46, is much to be deplored. He was appointed Chairman of Directors of the future permanent Institute, only so recently as June, 1918, with the object of organising the industrial scientific investigations of the Commonwealth. He possessed some special qualifications for the work to which he was appointed; but an attack of pneumonic influenza prematurely ended his promising career on 24th September, 1919, and deprived the Commonwealth of an able officer for whom it will be difficult to find a substitute with like qualifications.

Several of our Members, including Mr. J. E. Carne, Mr. T. Steel, Mr. C. T. Musson, Mr. A. G. Hamilton, and our Corresponding Member, Sir Baldwin Spencer, of Melbourne, have recently retired from active official work, but happily without losing their interest in scientific work generally. Mr. Carne's connection with the Department of Mines dates from 1879, and, on his retirement at the end of the year, he had been Government Geologist for about four years. His contributions to a knowledge of the geology of New South Wales are numerous and important; and all he knows is not yet on record. Mr. Steel has been associated for many years with an institution which provides one of our necessary food-stuffs, and, at the same time, is notable for its appreciation of the importance of the application of science to industry, and for its regard for the status and welfare of its scientific officers. Mr. Musson has been a member of the scientific staff of the Hawkesbury Agricultural College ever since its foundation in 1891. Mr. Hamilton has been connected with the Department of Education for many years, and latterly a member of the staff of the Teachers' Training College. Professor Baldwin Spencer, by his professorial work, his zoological and anthropological contributions, and the scientific records of his travels in Australian out-of-the-way places, has deservedly come to the front as one of Australia's representative men of science. Those of the younger generation who are coming on, nowadays more than ever, need the encouragement, the help, and a share of the fruit of the long experience of veterans such as these; and we may be sure that it will not be withheld when the opportunity offers. The Society is fortunate in having three of them still on the Council.

To Mr. E. C. Andrews, who has been appointed to succeed Mr. Carne, I would offer, on behalf of Members, our cordial congratulations, not only on his appointment to the important position of Government Geologist, but also on his having such worthy predecessors to follow, in carrying on the development of the geological knowledge of New South Wales.

To Dr. J. B. Cleland, who has recently been appointed to the newly established Chair of Pathology in the University of Adelaide, our congratulations are due. We regret that his removal to another State deprives us of an active Member, and also a Member of Council. But we know that his qualifications include much valuable experience, and that his appointment to Adelaide means an opportunity of undertaking effective work in a new field. We wish that he may be very successful.

To Dr. T. Storie Dixson, too, one of our senior Members, I would like to offer, on behalf of Members, our congratulations on the recent announcement in the newspapers, that His Gracious Majesty the King, as Patron, has conferred upon him the honour of Knight of Grace of the Order of St. John of Jerusalem in England, in recognition of his long and enthusiastic services in connection with the St. John Ambulance Brigade, of which he is Commissioner in New South Wales.

A change of printers became necessary during the year, and I am glad to say that our new printer is giving satisfaction. The cost of printing of every kind, however, has increased considerably. Taking advantage of the opportunity of making fresh arrangements, the Council has decided to enlarge the size of the Proceedings, from demy octavo to crown quarto, retaining the same size type, commencing with the volume for 1920. This will not only give more room for illustrations, but will simplify the work of supplying the reprints, which, by arrangement with the University, are furnished to Linnean Macleay Fellows, who carry out their research-work in the University laboratories, under the Regulations for Research Students. These, hitherto, have had to be specially printed.

The issue of the Monthly Abstracts, which was temporarily suspended, under war-conditions, after July, 1916, was resumed after the Meeting in October last, and will be generally appreciated, because it keeps distant Members and Societies in touch with what the Society is doing in the intervals between the issues of the successive Parts of the Proceedings. I would remind Members of the Council's injunction that the notices of exhibits at Meetings should be as brief as possible, and confined as far as possible to the scientific aspect of the specimens shown. Members are asked also not to exhibit too great a variety of different exhibits at the same Meeting, as this is likely to necessitate too complicated and too lengthy entries in indexing them.

Concomitantly with the growth of the Society's library, and of the natural accumulation of its reserve-stock of publications, we have, for some years past, felt a pressing need for more shelf-room, and more storage-room. During the recess, the Council has provided for some important structural alterations in the Society's Hall, to meet these and other requirements, together with the installation of the electric light, and for some necessary, new lavatory arrangements. These have been completed in a very satisfactory manner by the contractor, Mr. James Leckie, under the able superintendence of the architect, Mr. A. W. Warden, in time for the Annual Meeting.

The year's work of the Society's research-staff may be summarised thus. Dr. R. Greig Smith, Macleay Bacteriologist to the Society, contributed two papers on "The Germicidal Activity of the Eucalyptus Oils," which appeared in Parts i. and ii. of the Proceedings for 1919. He has also completed a paper "Ropiness in Wattle-bark Infusions," which will be communicated at this month's Meeting.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Biochemistry, has carried out an elaborate examination of the leaves, and also of the nuts, of *Macrozamia spiralis*, but, in both cases, the extracts failed to yield evidence of the presence of any poisonous substance, which was detrimental when fed to animals. A considerable amount of experimental work has been carried out with *Heterodendron oleaefolia*, in order to obtain the cyanogenetic glucoside which is contained in the leaves. The active principle can be concentrated into viscous syrup, but hitherto all attempts to induce it to yield a crystalline compound have failed. The results of these two investigations will be communicated to the Society, at an early date, in two papers, entitled, "The Chemistry of *Macrozamia*," and "The Stock-poison *Heterodendron*, including experiments on the Hydrocyanic acid Content." In addition to the foregoing, work is in progress on the Native Pomegranate (*Capparis Mitchelli*), which has proved to be another cyano-genetic plant, though not hitherto known to be, or even suspected of being poisonous. Also, a continuous series of quantitative experiments has been made, to determine the amounts of hydrocyanic acid evolved from *Zieria Smithii* under various conditions.

Dr. R. J. Tillyard, Linnean Macleay Fellow of the Society in Zoology, contributed seven papers during the year, all of which have been published. These include—"On the Morphology and Systematic Position of the Family *Micropterygidae* (sens. lat.), Introduction and Part i.; "Mesozoic Insects of Queensland," Nos. 5, 6, and 7; "A Fossil Insect Wing belonging to the new Order Paramecoptera, ancestral to the Trichoptera and Lepidoptera, from the Upper Coal Measures of Newcastle, N.S.W."; "Studies in Australian Neuroptera," No. 8; and "The Panorpoid Complex. Part iii." Dr. Tillyard intends to continue working upon the life-histories of Australian Neuropteroid Insects, and to make an attempt to bring the systematic knowledge of certain groups up to date in order to facilitate his morphological work. In October, the Council granted him permission to visit New Zealand, in order to obtain important material for the further working-out of the phylogeny of the Panorpoid Orders, and especially the Family *Micropterygidae*, which has its headquarters there; and also to collect material in all Neuropteroid groups, in order to study it in conjunction with the closely allied Australian fauna. Good results were obtained, except in the Rotorua-Taupo district, where the rainbow-trout introduced into the lakes had exercised the first call on the insect-fauna in which he was mainly interested. But this visit to New Zealand opened the way for an offer of the position of Biologist at the Cawthron Institute, about to be established at Nelson, which Dr. Tillyard has decided to accept; and, after to-day, we part with our Senior Fellow next to Dr. Petrie. He has been a member of the Society's research-staff for five years; and his papers during that period have been a prominent feature in the Society's Proceedings. He has not only studied the Australian aspect of world-problems, but he has tried to open up world-problems from the Australian standpoint; which is my idea of what Australian workers, as far as possible and according to their opportunities and resources, should aim at doing. In losing Dr. Tillyard, what we regret is not so much that we are losing him as a Fellow of the Society, but that Australia is losing him; and that our hopes, that an opening for doing what he is about to undertake in New Zealand, would be available for him in Australia, have been without result. Consequently, it merely remains for me to voice, on behalf of the Council and of the Society, our appreciation of the importance of the work which he has been doing so enthusiastically for so long; of expressing our sincere regret at losing him, not only as a Fellow of the Society, but most of all as a scientific worker resident in Australia; and of wishing him every success in the new sphere of work which he is about to enter. At any rate, I think he will be ready to acknowledge that his official connection with the Society has been helpful to him as a research-worker; and that the fruits of his work are, in some measure, his tribute to the memory of the benevolent and far-seeing man who made the Society's Fellowships possible.

Dr. H. S. Halcro Wardlaw, Linnean Macleay Fellow in Physiology, utilised the opportunity afforded by the outbreak of pneumonic influenza, in the early part of the year, of making an important investigation in connection therewith. Measurements of the oxygen-capacity and other properties of the blood of influenza-patients were made; and the results were embodied in a paper entitled "The Venous Oxygen-content and the Alkaline Reserve of the Blood in Pneumonic Influenza," which was published in Part iii. of the Proceedings for 1919. The work on the reciprocal dialysis of blood and milk has been continued. The effect on the total solid matter, ash, chlorine, phosphoric acid, and calcium has been examined. It has been found, contrary to expectation, that, when milk is dialysed against the blood of the same species, certain of the inorganic constituents of the milk pass into the blood in considerable quantity. The further surprising result, that the presence of the red corpuscles of the blood materially diminishes this effect has also been obtained. An interpretation of these phenomena has not yet been arrived at, and will need further consideration; as do also some other incompleted investigations. Dr. Wardlaw resigned his Fellowship in September, in order to take up a University appointment as Lecturer and Demonstrator in Physiology; and, in this capacity, he is taking part in the work of the Commission appointed to investigate the prevalence of disease among mine-workers at Broken Hill. While regretting the Society's loss of Dr. Wardlaw as a Linnean Macleay Fellow, I would offer to him, on behalf of the

Council and of Members, cordial congratulations on his appointment to the staff of the University, and of wishing him every success. His five papers contributed to the Society's Proceedings, as a Fellow for more than three years and a half, are important additions to the volumes, and bear testimony to his ability to do high-class research-work.

Miss V. Irwin Smith, Linnean Macleay Fellow of the Society in Zoology, has devoted her time to the study of Nematodes, and of the life-histories of the Brachycerous Diptera. Considerable progress has been made with both groups, in collecting material, in looking into the literature of the subject, and in the examination and drawing of specimens; and the results are already very promising.

Six applications for Linnean Macleay Fellowships, 1920-21, were received in response to the Council's invitation announced on October 29th, 1919; I have now the pleasure of making the first public announcement of the Council's re-appointment of Dr. J. M. Petrie and Miss V. Irwin Smith to Fellowships in Biochemistry and Zoology; and of the appointment of Miss M. I. Collins, B.Sc., to a Fellowship in Botany from 1st proximo; and, on behalf of the Society, as war-conditions have given place to something approaching a normal state of things, I have much pleasure in wishing them every success in carrying out their investigations. Dr. Tillyard was also re-appointed; but, as already mentioned, in consequence of his contemplated removal to New Zealand, he resigned his Fellowship as from 31st March, 1920.

Miss Collins has qualifications which justify our expectation of an enlargement of the Society's scope of work in a very desirable direction. She has an excellent University record, supplemented in an important way by some experience of research-work and of teaching. She won the Deas Thomson Scholarship and Professor David's Prize for Geology in 1914, and graduated in Science in 1915, with First Class Honours in Botany. Miss Collins was awarded a Science Research Scholarship in 1916 and the following year, up to the time of her appointment as Demonstrator in Botany in the University of Adelaide under Professor T. G. B. Osborn. For some time she has been actively interested in the effect of certain climatic factors—especially drought and excessive sunlight—upon the distribution and structure of Australian plants. This is a very characteristic, important, comprehensive, and promising Australian problem. Her paper "On the Leaf-anatomy of *Scaevola crassifolia*," with special reference to the "Epidermal Secretion," which was published in the Proceedings for 1918, was the starting-point. In several papers almost ready for publication, the condition of leaf-lacquering and the glandular structures responsible for the same, have been investigated in plants of other genera available, some of which were obtained from the Broken Hill district. Miss Collins will now have time to complete these, and still further to develop the subject in hand. Two branches of Science in which the Society is specially interested, and in which progress has lagged behind, are the morphology of Australian phanerogams, and Australian soil-bacteriology and the bionomics of soil-organisms, especially in the arid parts of Australia. Our old member, Mr. A. G. Hamilton, with only such laboratory-facilities as a private individual can extemporise, and in his wearied leisure, has, for years, manfully striven to accomplish some morphological and pollination-work; and, considering his drawbacks, his labours have not been in vain. The great hindrance to progress in this particular branch has been that, until 1913, there was no Botanical Department at the University, and no properly equipped botanical laboratory in this, the Mother-State of the Commonwealth. The Professor of Botany has been carrying out important investigations on Australian Cryptogams since its establishment. But Australian Phanerogams offer a no less attractive and important field for morphological research-work. We cannot but hail, with great satisfaction, the appointment of Miss Collins, because this is not only the first time that a Linnean Macleay Fellow in Botany has been appointed, but it is the first time that a botanical candidate has offered. Moreover, she is interested in Australian problems; and it is the investigation of characteristic Australian problems that is urgently needed, to the exclusion of purely academic biological problems which can be carried out anywhere else on the habitable globe; and which may be left to those who lack the opportunity or the resources for otherwise getting to work. Another source of satisfaction is that the systematists may now hope for some of that needful co-operation, without which they have had to work, as best they could, for so long.

Dr. A. B. Walkom, who succeeded me as Secretary, to-day completes his first year of service. As a Member of the Society since 1909, and as a Linnean Macleay Fellow in Geology, 1912-13, he began with some preliminary knowledge of the Society and its work, and was not a stranger to us. As Hon. Secretary of the Royal Society of Queensland for four years, and as President for one year before his removal to Sydney, he had the opportunity of gaining experience which has been very useful to him and to the Society. He was Lecturer in Geology in the University of Queensland for six years, and was selected by the Council out of thirteen candidates. As I have co-operated with him in preparing an up-to-date catalogue of the serial publications in the Society's library; and, in other ways, have been in close touch with him ever since his appointment, it affords me much pleasure to bear my testimony to his capacity for taking up and carrying out his duties, as well as to his zeal and efficiency.

The Council has also been able to provide for an assistant; and I have pleasure in saying that Miss Watson is very efficiently carrying out her duties.

One of the lessons which the War has forced upon the attention of the British, as well as other nations, is the importance of Science in the conduct of human affairs, and especially the need of a more satisfactory organisation of scientific effort. Scientific experts in Great Britain are expressing the views, not only from the purely British standpoint, but also from the British national or imperial standpoint. Through their representative, the Royal Society of London, they are asking the Dominions not only to co-operate with the mother-country to this end, and for this purpose; but also to join with the mother-country in an International co-operative effort with which it is associated, and for the establishment of which, some progress has already been made, as the result of two Inter-Allied Conferences on the future conduct of scientific work of an international character, held in Paris, November 26-29, 1918; and in July, 1919. Accordingly, early in the year, the Royal Society of New South Wales, as the senior Scientific Society of the Commonwealth, was asked by the Royal Society of London "to take the necessary steps to establish some organisation in Australia which could act as a National Research Council and nominate National Committees of such Associations as you may desire to join."

The Royal Society of New South Wales accordingly communicated with the Scientific Societies in the different States of the Commonwealth, asking them to appoint delegates; and when this had been carried out, it arranged for a Conference of the delegates to consider the proposal to form an Australian National Research Council. The Conference was held on 21st August, 1919, when certain Resolutions were unanimously passed. As it is desirable that publicity should be given to these before the next Meeting of the Australasian Association, in January, 1921, they are accordingly included herewith. I may say that, in the appointment of representatives, the effort was made to have all the States represented, as far as it was possible. To save space, only the representatives of the branches of Science in which the Society is directly interested are given.

1. That this meeting proceed to nominate a provisional Australian National Research Council.

2. That each important branch of science in Australia be represented on the Council.

3. That the branches of science to be represented include: Agriculture, Anthropology, Astronomy, Botany, Chemistry, Engineering, Geography, Geology, Mathematics, Meteorology, Pathology, Physics, Physiology, Veterinary Science, Zoology.

4. That there be two representatives of each of these sciences, on the National Council.

5. That the representatives of the provisional Australian National Research Council be:—

1. AGRICULTURE—
A. E. V. Richardson, M.A., B.Sc. (Victoria).
Professor R. D. Watt, M.A., B.Sc. (New South Wales).

2. ANTHROPOLOGY—
C. Hedley, F.L.S. (New South Wales).
Sir Baldwin Spencer, K.C.M.G., M.A., D.Sc., F.R.S. (Victoria).

4. BOTANY—
J. H. Maiden, I.S.O., F.R.S., F.L.S. (New South Wales).
Professor T. G. B. Osborn, M.Sc. (South Australia).

8. GEOLOGY—
Professor T. W. E. David, C.M.G., D.S.O., B.A., D.Sc., F.R.S. (New South Wales).
Professor E. W. Skeats, D.Sc., F.G.S. (Victoria).

13. PHYSIOLOGY—
Professor H. G. Chapman, M.D., B.S. (New South Wales).
Professor W. A. Osborne, D.Sc., M.B. (Victoria).

14. VETERINARY SCIENCE—
Professor J. D. Stewart, B.V.Sc., M.R.C.V.S. (New South Wales).
Prof. H. A. Woodruff, M.R.C.V.S., M.R.C.S., L.R.C.P. (Victoria).

15. ZOOLOGY—
Professor W. J. Dakin, D.Sc., F.Z.S., F.L.S. (Western Australia).
Professor W. A. Haswell, M.A., D.Sc., F.R.S. (New South Wales).

6. That Mr. R. H. Cambage, F.L.S. (New South Wales) be a member of the Australian National Research Council and also its Honorary Secretary.

7. That the provisional Council hold office until the new Council shall have been appointed at the next meeting of the Australasian Association for the Advancement of Science, in January, 1921.

8. That the election of the new Australian National Research Council be entrusted to the Council of the Australasian Association for the Advancement of Science at its meeting in January, 1921.

9. That at least ten of the retiring members of the Council shall not be eligible for re-election, but that this provision shall not operate at the election of the first Australian National Research Council in January, 1921.

10. That a provisional Executive Committee consisting of a Chairman, an Honorary Secretary, and three other members be appointed to act at once in all matters considered urgent, and that the members of such Executive Committee be:—Professor David (Chairman), Mr. R. H. Cambage (Hon. Secretary), Professor Chapman, Mr. J. H. Maiden, and Professor Pollock.

11. That it be recommended to this provisional Executive Committee that the Commonwealth Government be requested to make the financial provisions necessary for carrying on the work of the Australian National Research Council, and that for this purpose representations be made to the Prime Minister.

12. In the event of any of the members of the provisional Council or the Executive Committee, declining to accept office, that the Executive be empowered to fill the vacancies.

The International Research Council has already provided for the establishment of (1) An International Astronomical Union to promote and co-ordinate the study of Astronomy and Astrophysics; (2) An International Union of Geophysics, to promote the study of the various branches of the Physics of the Earth; and (3) An International Chemical Council, to promote international co-operation in chemistry. Steps will be taken to establish cognate Unions for other branches of Science. In the meantime, the Australian National Council has asked its representatives of Zoology to report on the desirability, or otherwise, of joining the International Union of Biological Science (when it shall have become established), more particularly as regards the section of Zoology; and they are inviting others to confer with them. The object aimed at in forming an International Union of Biological Science is "to encourage the study of Biology in its various branches, and more especially":—

(a) "To initiate and organise the conduct of researches which depend on co-operation between countries.

(b) "To provide for their scientific discussion and publication."

(c) "To encourage the establishment and improvement of Research Laboratories which are accessible to students of all nationalities."

(d) "To promote the organisation of International Congresses."

(e) "To facilitate the preparation and issue of bibliographical publications."

The sections proposed are—General Biology, Physiology, Zoology, Botany, Medical Sciences, Applied Biology.

Now, theoretically, what is proposed as above is admirable, and no one can gainsay the need for it, or at least for something of the sort, if the resources for carrying it out are forthcoming. But there is also another side to the question, which is not less important for us, and that is, the question of more, and better organisation of scientific effort from the purely Australian point of view. How are we to provide for this? At present men of Science in Australia are but a handful, occupied with official duties, centralised in the capital city of each of the States, at considerable distances apart, with few opportunities for personal intercourse. The only comprehensive, unifying organisation in the branches of Science in which this Society is directly interested, is the Australasian Association for the Advancement of Science. As a private individual, interested in Science, I venture to express the hope, that, after the next Meeting, to be held in Hobart in January, 1921, the Association will give up entirely the practice of reading papers in the different Sections, with a view to restricting its activities in the following manner—to providing opportunity, (1) for personal intercourse between the Members; (2) for Presidential Addresses as at present; (3) for discussing prearranged scientific problems of Sectional or general interest; (4) for discussing matters relating to the organisation of scientific effort in Australia; and for doing what it can to accomplish it. In other words, that it should leave to the Australian Scientific Societies the matter of reading and publishing scientific papers; and assume the functions of an Australasian Parliament of Science, in the interest of promoting co-operation, and a better organisation of scientific effort.

As an example of one of many Australian problems—a world-problem in process of being opened up from the Australian standpoint, under Australian conditions—which is being carried out in the right way, namely by organised teamwork, and, not in Sydney, but at a remote country centre, where the problem takes its origin. I call your attention to a scientific investigation which is being carried out at Broken Hill, under the direction of one of our Members, Professor Chapman. A Technical Commission of Inquiry has been appointed recently, under the State Board of Trade, to investigate the prevalence of disease amongst mine-workers at Broken Hill. The investigations will occupy six months, and £15,000 has been allotted for the work. Professor Chapman, one of our Members, has been appointed Chairman of the Commission, and was asked by the Premier to associate with himself in the Commission such gentlemen as would be competent to take charge of different phases of the investigation. The Commission is making medical examinations of as many of the mine workers at Broken Hill as are available, with the object of ascertaining the degree of prevalence of miner's phthisis, lead-poisoning, and anchylostomiasis. It is hoped to study 4500 men who will form about 60 % of those employed along the lode. Two large X-ray machines have been installed and radiograms are made of each man's chest by Dr. W. A. Edwards. Six medical practitioners, working under the direction of Dr. S. A. Smith, are carrying out a thorough medical examination of each man. When needed special bacteriological and chemical and cytological tests are performed. Through the courtesy of the Commonwealth Government, the services of Dr W. A. Sawyer of the International Health Board have been made available to the Commission for the investigation of the occurrence of hookworm. As a result, a complete working-unit, comprising four microscopists and two assistants under the control of Dr. Rosenthal, has been transferred to Broken Hill from Queensland. The staff concerned in this medical investigation comprises seven medical practitioners, four microscopists, five assistants, and four statistical clerks, together with four members of the Commission. The Commission will endeavour to establish a relation between the sign and symptoms of disease noted in the mine worker, the appearance of the radiographic picture of the lungs and the pathological changes which can be observed in the lungs of dead miners. As the Commission has been asked to report on the conditions antecedent to the occurrence of ill-health among mine-workers, investigations are being made into the chemical and physical characters of the dust produced in the various operations of mining. Some analyses are being performed upon the ash of the lungs of mine-workers in the hope of adding to the store of our knowledge about the dust present in the lungs. Samples of the dust floating in the air of the mines are also being subjected to chemical and physical examination. This part of the work of the Commission has been under the control of Dr. H. S. H. Wardlaw, who is assisted by four chemists. We look forward, with great interest, to the results of this well-organised, well-equipped, co-ordinated effort, the most notable in these respects that we have yet had in New South Wales.

One of the events of the year has been the culmination of a disastrous drought; and though there has been relief in some districts, other localities are still much in need of rain. It has been a costly visitation to the State. The returns of the approximate number of live stock in New South Wales on 31st December, 1919, as compared with those of the corresponding period of 1918, show that there has been a decrease of 72,434 horses, partly due to very little breeding on account of low prices and small demand, and in part to the drought conditions experienced in many districts for the greater part of the year; of 399,378 cattle, attributable mainly to the effects of the drought, namely, to death from starvation, conditions not favourable to breeding, and the forwarding of cattle to market on account of the holdings not being able to carry large stock; and of 7,028,852 sheep, attributable almost wholly to the droughty conditions, which have been very severe on breeding-ewes, so that over the greater part of the State, the lambing was a failure.* In addition to the pecuniary loss represented by the depreciation of the State's flocks and herds by drought, it is necessary to take count of the fact that the Government is raising a loan of £1,000,000 by the issue of Treasury Bills bearing interest at the rate of 5½ per cent., with a currency of two years from March 1st, 1920, for the purpose of providing funds to finance advances to distressed farmers, and also to meet payments for seed-wheat purchased by the Government for issue to farmers, and for other purposes. The drought, therefore, has not only been another expensive intimation that Australia has still some lessons to learn about the solution of drought-problems; but that Australia has not learnt all there was to learn from previous similar experiences, particularly the drought which culminated in 1902, and was responsible, among other losses, for the reduction of the flocks of the State from forty-three to about twenty millions. "Prevention is better than cure," but as periodical droughts have a legitimate place in Nature's scheme of things in Australia, Man cannot, therefore, prevent their occurrence. But is it impossible to learn how to mitigate, if not to prevent, at any rate in some measure, the periodical levy on the wealth of the State by droughts? Why is it, for example, that it is left to droughts to cull the flocks and herds in the exacting way in which it is done by every serious drought? Answers to these, or other cognate questions are not hard to find. What Australia especially needs to learn is how to cope successfully with drought-problems; and to learn that, it is necessary to understand and take to heart, that droughts are teachers, and not a curse; since they are a legitimate factor in Nature's scheme of things in this quarter of the globe. Rabbits and Prickly Pear, &c., may be curses; but Nature is not responsible in any way for their foothold in Australia. A recent writer has diagnosed the state of Britain, before her eyes were opened by the War, in the following words†—"We have sloughed our besetting sins in many mental processes. Before the War, men of science were grossly academic and individual: often abstract to the point of perverted mysticism; and the line they took encouraged the men of commerce to the contempt of pure knowledge. Men of science, merchants, the banks, and the Government were all in watertight compartments, working apart, and more than

* For further details see the Sydney Morning Herald, February 26, 1920, p. 5 to which I am indebted for the particulars quoted.

† Thomas, W. B., "A Better England—Not a Worse," Nineteenth Century, No. 514, December, 1919, p. 1013.

this, contemning one another. The result was that, from the nation's point of view, the brains of the chemist were wasted, the activities of the merchants handicapped, the wealth of the banks locked up, and politicians a vain luxury. The British brain was working; but was a milch-cow for other astuter nations." What is here said or implied about the importance of the co-operation of men of science with commercial men and with Governments, and about the national lack of the appreciation and practice of it, before the War, is only too true. But the men of science are not, equally with others, to blame for it. For, from time to time, their representative spokesmen have pointed out what was needed, but their warnings and their recommendations have too often failed to arouse attention or elicit any response. Or if noticed, their views have been dubbed "counsels of perfection," or "arm-chair" advice, which the "practical" man can well afford to ridicule, or neglect altogether. Now, in the case of Australia, there is great need for a closer and more effective co-operation of Science with the primary producer, the man on the land. With the manufacturer also, but in this case, the need can be easily provided for, since all he has to do is to make the necessary provision for increasing his staff by the addition of such scientific experts, chemists or whatever they may be, as circumstances require. But the case of the primary producer is different, and it requires the most earnest consideration. It is necessary for him to learn and understand, what he is apt to overlook, or fail to realise the importance of—small blame to him, under the circumstances which have encouraged it—that there is a theoretical side to his practical activities, which needs to be taken into account; that in his case, as in others, the theoretical side and the practical side are complementary, since true theories are merely the generalisations upon which practice is to proceed. Now a lack of appreciation of this need of the recognition of the complementary relations of science and practice in relation to drought-problems is plainly in evidence in books and in newspaper records; and I shall refer to some of them presently. One imperative reason for taking account of them henceforth is, what is implied in the statement that "Australia's bid for greatness rests upon her agricultural possibilities";* and that considerable progress has been made in this direction since these words were recorded, with more to follow in the immediate future. The imperativeness of the reason referred to arises in this way. In the earliest days of settlement in the inland districts, the man on the land was a pastoralist solely. But now that he is devoting more and more attention to agriculture, it is necessary to remember that this means a steadily increasing removal of the natural covering of the soil—in the shape of forest, or scrub, or grasses, or whatever it may be—and that his operations necessitate, over a steadily increasing area, a profound disturbance of the soil-organisms and of their relations to the indigenous plants, which have come about as the result of Nature's long-standing arrangements. Now these are matters which cannot be treated with absolute indifference; for they mean much; and what they may do or mean, it is necessary to learn.

When Australia was colonised in 1788, the first settlers found everything very different from what they had been accustomed to. In due time, a spokesman took it upon himself to voice the strangeness of the land to which they had migrated. This was Mr. Barron Field, a Supreme Court Judge in Sydney from 1816-23. To him, the colonists were the antipodes of the old folks at home. Consequently Australia not only was, but ought to be, the Land of Upside Down. It was the great Freak-Land. The plants were freaks, the animals were freaks,

*Gullett, H. S., "Australia's Development: the Coming of the Farmer," Chambers' Journal, January, 1909.

the climate was freakish, the constellations were unfamiliar. He not only set about cataloguing the freaks—"But this is New Holland . . . where the swans are black and the eagles are white; where the kangaroo, an animal between the squirrel and the deer, has five claws on its fore-paws, and three talons on its hind-legs, like a bird, and yet hops on its tail; where the mole (Ornithorhynchus paradoxus) lays eggs, and has a duck's bill," &c., &c.* But he also proceeded to account for them on the supposition that other countries were created in the beginning, whereas the fifth Continent was an after-birth, not conceived in the beginning, but which emerged at the first sinning, and was, therefore, curst; and the freaks were the fruit of it.

At a later date (1884), another spokesman, Marcus Clark, expressed his views about Australia thus—"Europe is the home of knightly song, of bright deeds and clear morning thought. . . . In Australia alone is to be found the Grotesque, the Weird, the strange scribblings of Nature learning how to write. Some see no beauty in our trees without shade, our flowers without perfume, our birds who cannot fly, and our beasts who have not yet learned to walk on all fours."† These and similar effusions are not to be regarded simply as nonsense. On the contrary, they are most instructive and precious landmarks in the progress of a knowledge of Australia in Australia, in the days when Science was too undeveloped to offer the real interpretation. The spokesmen were educated men, but men of a too literary education, for whom science-teaching was not available in their youth; but what they said was untainted with the idea that gives birth to what is apt to be regarded as the only thing worth while, "That's the way to make money."

In Barron Field's time, even scientific men thought that species were created as such. If the animals and plants of Australia were freaks, then that was what they were intended to be. Marcus Clark might have read Darwin's "Origin of Species," but, if so, it failed to impress him. But to-day, scientific men can explain the supposed freakishness. Some of it was due to the fact that Australia was a sort of "Noah's Ark" for "living fossils"; some of it had no particular significance, but much of it was the outward and visible sign of successful adaptation to periodically arid conditions, whereby the supposed freaks were enabled to survive droughts, and to live in harmony with a variable and, at times, exacting environment. *Mutatis mutandis*, just what the man who goes on the land needs to know.

At a still later period, only sixteen years ago, another spokesman, another kind of spokesman, expressed his views about life on the land in Australia. These deserve caustic criticism, not merely because what the writer has to say is nonsense, but because it is pernicious nonsense. I refer to a leading article, entitled "Australian Pessimism," in the Evening News for April 4th, 1903. After remarking upon the absence of poems of a fresh, joyous nature written by an Australian; of successful attempts to write on the two topics which engross writers of most other nations—viz., love and home-life, the writer proceeds to say—"The secret is to be found in the conditions of existence here: life in the Australian bush is one long weary gamble with malignant fate; no man feels sure of his return for his labour and money; that incomprehensible deity known as 'luck' rules everything. The greatest care may be wasted, the greatest precau-

* Geographical Memoirs of New South Wales. Edited by Barron Field (1825), pp. 461, 494.

† Preface to "Poems of the late Adam Lindsay Gordon" (1884).

tions come to naught against the breath of drought or the ravage of the bush-fire. Life becomes a long watching, with as much cynicism and fortitude as the watcher can avail himself of, the turning of the great wheel of fortune, which deals out failure to one man, and success to another, quite irrespective of their merits. Under these circumstances, it is no wonder that a tone of cynical levity towards life is the dominant note of Australian literature. 'Home' is just a place where one makes money or loses it, as the case may be," and so on. Now the most appropriate label for this diatribe is just—"The Squeaker has squoken." Australia surely offers no *locus standi* to such an undesirable alien as fatalism. But fatalism harnessed to ignorance is a hopeless combination, which deserves no quarter from Science. Is there one returned soldier who would deliberately say, of the recent terrible war, that the incomprehensible deity known as "luck" ruled everything in connection with it, the only drawback being that the huge armies of the two sets of opponents had to engage in a death-struggle, in order to find out which side the incomprehensible deity favoured, and intended to win? No wonder that Australia has never been in a position to export a single bale of wool or of sheepskins, a single hide, or a frozen carcase! No wonder, also, that Australian bush-children have never learned to sing "Home, Sweet Home; there is no place like Home"! And how delightful, by comparison, it must be for a man on the land to live in a country where the thermometer is often down to zero or lower, for weeks or longer at a stretch, and the culled stock need to be housed and fed for about five months, more or less, out of the twelve!

Another writer, in reference to the 1902 drought, speaks of it as—"the struggle of man against a relentless, cruel environment; the sweeping away by overwhelming odds of fortunes, won by years of toil; of the barren mockery of 'what has been,' of disaster, desolation and ruin; of men stripped and wounded fighting to the end with enduring pluck."* Why not emigrate to Siberia, Russia, or Canada, which are not troubled with droughts, but merely have hard winters?

"Old Saltbush" (Walter Smith) in his poem entitled "Drought; written in 1877, when the Drought was at its worst,"† furnishes another example. This is really, though it is not what it was intended to be, the story of a squatter who, after a run of good seasons, thought he would take a sporting chance for just one year more, at any rate; or perhaps he tossed-up over it. But the drought came when he was not expecting it, and caught him wholly unprepared, with a full complement of stock and sheep. It will be noticed that the starving animals are not spoken of as crawling around the empty siloes, or the dried-up dams, or about the artesian bore, which is on strike, but only along the banks of the empty "great stream-beds," where the "rotting carcasses" are. The following is portion of what the poet has to say about it:—

In the great stream-beds, muddy holes
Where once was water deep,
Are filled with rotting carcasses
Of cattle and of sheep;
Along the banks in ghastly groups
(Full half their number gone)
The starving stock all feebly crawl,
Poor wrecks of skin and bone.

. . . . .

Oh! Demon Drought! that sweeps away
The hard-earned wealth of years, etc.

* Sydney Morning Herald, November 17th, 1908, in "On the Land" column.

† Australian Ballads and other Poems, selected and edited by D. Sladen, p. 261.

Still another quotation, this time a character-sketch from an article entitled "The Man Out Back," published in the Sydney Daily Telegraph of December 29th, 1906. "Times have changed, and a certain type of the old Australian pioneer has well-nigh gone. He was one who did things in a large way, and usually made his fortune. He was an interesting character, and his methods, if primitive, were effective. Rough in speech, plain of dress, fond of hard work, with long hours and simple food, he was yet genial in company. In business, he was usually hard and stern, and he was especially noted for his shrewd dealings in money-matters. He lived to make money, and any hindrance that stood in his way was brushed aside by his strong personality. 'A pound saved is as good as two pounds made,' one that I knew used to say. He succeeded, and accumulated money, and, what is more to the point, stuck fast to it. 'You'll have to leave your wealth behind you, and whoever gets it will probably spend it recklessly,' I said to him once, with a frankness that did not displease him. 'Well,' he answered with a hard laugh, 'if those who come after me get half as much pleasure in spending it as I have had in making the money, I'll be perfectly satisfied.' When he took up 250,000 acres in the back country, he was content with a poor dwelling-place. A shelter from the rain was almost the main consideration. He did not believe in making improvements. 'Eat out the country, and then move elsewhere, was his motto. 'If they want you to make improvements, throw up the country,' he said. In time of drought his sheep were dying for want of water and feed. 'Let them die; it doesn't pay me to feed them. I can buy plenty more when the rain comes. That's the way to make money.'"

What is amiss with the sentiments expressed in the extracts quoted? They are wrong in at least two respects. Firstly, they are views of Man's relation to Nature based upon self-interest, that is upon his money-making instinct—the idea that it may be cheaper and less trouble to take chances, even if it results in drought culling the flocks and herds, than it is to learn how to prevent it; and that "That's the way to make money." And, secondly, they take no account whatever of the complemental, scientific side of what droughts are, of what they mean, and of the part they play in the economy of Nature, and of Man's concern with them from this point of view.

Man needs rest after strenuous work, whether physical or mental; and the physiologist can give a scientific explanation of the need of it, and of the result of it.

The land also periodically needs a rest or sweetening, and the biologist can give a scientific explanation of the need of it, as well as of the result of it. It is a matter of experience, that the year after a drought breaks up, is a bumper year for crops and herbage.

Nature has adopted two ways of resting and sweetening the land, and, at the same time, of generally clearing up and putting things in order, getting rid of weaklings and undesirables, and putting species, that have got out of bounds, back into their proper places. These are, (1) annually recurring, hard winters, as in the extra-tropical countries of the Northern Hemisphere, the hardness varying with the latitude. This may be distinguished as the winter-sleep or resting of the land. And (2) periodical droughts in the subtropical countries of the Southern Hemisphere, like Australia, Subtropical South America, and South Africa, which have mild winters, not severe enough to give the land a thorough rest or sweetening. The arrears accumulate until, sooner or later, the drought comes, puts things straight again, strikes a balance, and makes way for a new start, the onset of the bumper year. This may be distinguished as the drought-sleep or resting or sweetening of the land. The difference between Nature's two methods of doing the same kind of thing depends on geographical position, and on cosmical conditions of high and low pressure areas, sun-spots perhaps, and so on; and, of these, the meteorologist and the astronomer can give a scientific account.

Therefore, to rail at droughts, to call them a curse, to speak of them as responsible for a relentless, cruel environment for the man who goes on the land in Australia, or as a Demon who robs the squatter of his hard-earned wealth, some of it earned simply by allowing Nature to convert grass, her own grass, into wool and mutton, is to be as ignorantly foolish as to say, night, the need of sleep and recreation, the Sabbath-day's rest, and holidays are curses, unfriendly Demons, because they nightly, weekly, or periodically interrupt his money-making activities. And it might be supplemented by lamenting that Man is such an imperfect creature, because a perfect man should have an iron constitution, which would enable him to dispense with sleep and rest, so that he might uninterruptedly be making money, twenty-four hours per diem, seven days per week, three hundred and sixty-five days per annum, year in and year out. That would be the way to make money!

The man on the land in the Northern Hemisphere, after generations of experience, has learned his lesson, and is able to live in harmony with his environment. The severity of the annually recurring winters compels him to house and feed his stock; therefore, he must grow enough fodder to provide for them, and he must cull his flocks and herds, so that the demand for fodder shall not exceed the supply. What helps him to learn his lesson is, that the recurrence of winter-conditions, on the whole, is so regular, that he can arrange his programme of work by the almanac; and, not less, that he certainly knows that he will be ruined, if he does not come up to the mark. So, knowing exactly what he has to do, and how to do it, and what will happen if he fails to do it, he makes good; and abstains from talking nonsense and heresy about his relentless, cruel environment, even when the thermometer goes below zero; or about winter being a curse. In a word, he becomes a philosopher, in the primary sense of the word; and the idea of a long, weary gamble with malignant frost and ice finds no place in his mind.

The man on the land in Australia, Subtropical South America, and South Africa, has to carry out his work on a different basis, inasmuch as he has to learn how to adapt himself to Nature's arrangements for giving the land its needed rest and sweetening, not by a regularly, annually recurring winter-sleep, but by a periodical but not regularly recurring drought-sleep. Nature, in Australia, has provided a genial climate, with splendid natural pasture-grasses and fodder-plants; with no hard, annually recurring winter, requiring the man on the land to house his stock, and grow crops to feed them under those circumstances, as well as to cull out all but what he can feed; and, in many cases, with procurable water, though it may not always be visible on the surface. Nevertheless, he has not yet learned to live in harmony with his environment, so successfully as his representative in the Northern Hemisphere, because, though he knows from experience or from historical records, that droughts are certainly to be looked for from time to time, he cannot tell from the almanac exactly when to expect them. This recurrence of droughts at uncertain intervals, which he cannot calculate,—and Science cannot definitely help him in that respect at present—is a disturbing factor, which periodically makes his environment erratic, and puts him out of harmony with it. This uncertainty introduces the temptation to take chances, which may be disastrous, and underlies the idea of the "Gamble out West."

What Australia needs to learn, by the guidance and co-operation of Science —and there is no better way of doing it—is, how to insure against damage by droughts. That is:—(1) How to prevent the production of "necessitous farmers," requiring State aid, to the amount of about £1,000,000, in order to rehabilitate themselves after a visitation of drought. The State Treasurer reports that, already, £600,000 has been disbursed for this purpose. Do hard winters in the Northern Hemisphere ever or often produce "necessitous farmers" requiring to be relieved by the State, to such an amount?

(2) How to prevent droughts from culling the herds and flocks, on the customary colossal scale; and from obliterating the promise of harvests.

This can be expressed in another way—How can the man on the land in Australia, with the aid of Science, learn to solve the following questions?

1. In attempting to insure against, or to cope with droughts, is he attempting to accomplish the impossible; or is he only in some districts, or in some cases, trying to accomplish the impossible?

2. Or is he attempting to accomplish the possible (a) in the right way; or (b) with good intentions, but with insufficient knowledge or equipment, or with inadequate resources?

From time to time, especially on festive occasions, important personages indulge in forecasting the future population of Australia as 100 millions, or even 200 millions, and in descanting upon the necessity of filling up the empty spaces of the continent, but, in the reports of their speeches in the newspapers, as far as I have seen, without insisting on the very necessary stipulation—if and when Australia learns, or is going to learn, or has learned, how to cope with drought problems. The strength of a chain is the strength of the weakest link. The population that Australia can support, is the population that she can safely carry when droughts come. The State is recovering in part from a very severe experience of drought. Great activity is being displayed in all the States in the way of facilitating the settlement of returned soldiers, and immigrants on the land. This Meeting seems to me to be an opportune occasion for asking what, I think, is a proper and a pertinent question, because drought problems are primarily scientific problems, and, therefore, the guidance and co-operation of Science is needed for their solution. The question, I would ask, is the twofold, neglected question—How is it, seeing that drought-problems are so very important, that we have no Handbook, or Manual, or *Vade mecum* of Australian Drought-Problems; and if not, why not; and how soon may we look forward to having one? We have manuals of the flora, of the fauna, of the birds, of the fishes, of the fungi, of the fodder-plants and grasses, of the minerals and fossils, and so on; and we know them to be of fundamental importance, and to be most helpful and suggestive, in the investigation of problems to which they relate. In anticipation of the visit of Members of the British Association for the Advancement of Science in 1914, an admirable series of Handbooks, one for each of the older States, and one for the Commonwealth as a whole, was published. These served not only for the enlightenment of the visitors, but are standard works of reference to-day. What I have in view is something different from these, and something which is not intended in any way to clash with, or supersede the publications of the State Department of Agriculture, for example, some of which contain articles bearing upon some aspect or other of drought-problems. It is not to be a book to teach the man on the land how to grow crops, or how to raise stock, primarily, or how to accumulate shekels, or anything of that sort. It is to be a book solely for the purpose of setting forth the complemental, theoretical side of the practical activities of the man on the land, especially in relation to drought-problems, with the object of enabling him to understand what it is he needs to learn in order to make the most of his resources in providing against disaster; that is how to live and keep in harmony with his somewhat erratic environment: and to understand that drought is not a curse, and that he is not called on to fight droughts, but to fight his ignorance about how to cope with them, which ought to be, sooner or later, enlightenable, provided that Science is afforded an opportunity of helping him.

Apart from the fact that no such book, as I have proposed, is available at present, the need of such a book is not that nothing at all is known about drought-problems, but that so much of what is known is to be found in back numbers of newspapers or in scientific journals, where it is not accessible to those who want it, and could make use of it; and that these contributions to knowledge deal only with particular aspects or cases, and not comprehensively with the subject in its entirety. What is wanted, as I think, is a selfcontained Handbook of the complementary, theoretical side of drought-problems. I give a sketch of the ground that, in my opinion, might be covered by it, just as something for consideration and discussion:—

SYNOPSIS.

Nature and Man, Nature's Insurgent Son—Disturbance of Nature's Balance by Settlement, and what that involves; the reckless or careless introduction of undesirable Aliens, like Rabbits, Prickly Pear, &c.; and the reason why they flourish in their new environment—Droughts: their History and Periodicity in Australia—Droughts in South Africa, and Subtropical South America—Their Cause and Meaning in the Economy of Nature: Nature's two ways of resting or sweetening the land, and, at the same time, of clearing up, putting things in order, and striking a balance, by (1) severe cold, or (2) more or less intense aridity—The year after a drought, the bumper year for crops and herbage, and the scientific explanation of the resting and sweetening of the land—The Lessons to be learned from the high level and low-level Flood-plains of the Hawkesbury River Valley, as in evidence at Richmond; and from the desiccated Lake Eyre Basin of Central Australia, called by Gregory "The Dead Heart of Australia"—The Adaptations of the indigenous Plants and Animals to arid conditions, and the lessons to be learned from them—The Man on the Land in the Northern Hemisphere, with an annually recurring hard winter, in harmony with his environment—The Man on the Land in the Southern Hemisphere, with mild winters but periodical droughts, whose periodicity cannot at present be calculated, not yet wholly in harmony with his environment—The need to conserve the fertility of the Soil, and the indigenous grasses and fodder-plants—Disturbance of the Soil-organisms, and of their long-standing association with the indigenous Plants, especially the Acacias and Eucalypts; the Bionomics of Soil-organisms in the arid portions of the Continent; and the risks from strong, dry, Westerly Winds, in the absence of a covering of Snow, when the natural covering of the ground has been removed—Lessons from Droughts; and the Application of the Lessons—Bibliography, as a guide to more detailed consideration of special subjects—Index, &c.

Happily there have been and are men on the land in Australia, who have learned that droughts are not a curse, though rabbits and prickly pear may be;

that the land needs a periodical rest or sweetening; that it is the dry climate and the high-class nutritive native grasses and herbage, which are largely responsible for the excellence of Australian wools; that if every season were a good one, the stock and sheep would suffer severely from parasites, and from diseases; and, best of all, men who do not believe that Nature's great scheme of things, which, by slow degrees, has evolved from the womb of Time, has arrived at its present advanced state of development, for the sole and only purpose of gratifying the money-making instincts of the Get-rich-quick Dollarton Shekelfords, just as and how they would like to be able to order it. Records of the actual experience of intelligent and enlightened men of this kind, are among the things wanted; and some of it is already on record in the files of old newspapers. They are men who can appreciate the words of Mr. Roosevelt, when President of the United States, in his opening Address to the American Forest Congress, held at Washington, January, 1905—"All of you know that there is opportunity in any new country for the development of the type of temporary inhabitant whose idea is to skin the country and go somewhere else. . . . That man is a curse and not a blessing to the country. The prop of the country must be the business man who intends so to run his business that it will be profitable to his children after him. . . . I ask, with all the intensity I am capable of, that the men of the West will remember the sharp distinction I have just drawn between the man who skins the land, and the man who develops the country."

The book should not be a one-man book, but a team-work book, supervised by a capable editor. It should be simply but scientifically written by specialists in the different branches, after the manner of the Handbooks prepared, at different times, for the Meetings of the Australasian and of the British Associations for the Advancement of Science. But, for the chapters to which they relate, and especially those on the lessons of droughts and their application, from the practical man's side, the files of the newspapers, at least as far back as the drought which began in 1888, should be systematically looked up. Some of the articles therein are excellent, for they are often the records of actual experience and first-hand knowledge; and, as such, they are of historical interest. The cream of all these should be skimmed, supplemented as may be required, and put into the Handbook; and, if desirable, referred to in the Bibliography. Papers in scientific journals should be utilised in a similar manner.

But the publication of a Handbook, in the way of propaganda, is not enough. The annual output of books is so enormous, that any particular book is apt to be put on the shelf, and perhaps forgotten. Therefore some propagandists are needed. A good way of providing for these, I think, would be the endowment of a course of three annual lectures. One lecturer always to be a scientific man; another always to be a man on the land; and the third always to be a business man capable of dealing with the statistical and financial aspects of drought-problems. The lecturers to be appointed annually, a year in advance, so that they may have time for the preparation of their lectures. The lecturers to be allowed to choose the subjects of their lectures, provided—and this is to be a *sine qua non*—that the aim and object thereof is to elaborate, to expound, to make clear, and, if possible or necessary, to amplify the Handbook. The lectures sometimes to be delivered in Sydney when the primary producers come to hold their annual Congresses; and, sometimes in one or other of the centrally situated and accessible country towns, as may be decided. In this way, attention would periodically be focussed on the Handbook, and on the subject with which it has to do. Discussion thereon would be promoted. If taken up and entered into enthusiastically, the subject of drought-problems should become a live subject, as it ought to be, and as it needs to be; and then we may expect to make some progress.

Next only to the need of righteousness, and of the maintenance of the integrity and welfare of the Empire, the question of how to cope successfully with droughts in Australia, stands second to none in its importance. For Australia's bid for greatness rests upon this, inasmuch as her agriculture and other possibilities can only be imperfectly realised without it.

On the correct Interpretation of the so-called Phyllodes of the Australian Phyllodineous Acacias.

(Plates i.-viii.)

The Australian flora furnishes numerous examples of plant-structures, which, as one usually sees them, are difficult to understand, partly because they represent secondary developments which have been superimposed on the primary, natural order of things; and partly because one commonly meets with complicated adult structures, of which the early stages are not always readily obtainable. The so-called phyllodes of Australian Acacias are one of the most common and familiar examples of these plant-puzzles. These have been regarded as the "classical" examples of phyllodes, because there are so many species of phyllodineous Acacias, and they are so widely distributed. Nevertheless, strictly speaking, they are not "phyllodes" within the meaning of the recognised definition of these leaf-substitutes. For example, in the Glossary of Terms prefixed to the first volume of the Flora Australiensis (p. xxxix.) will be found the definition—"Phyllodium = a flat petiole with no blade." Asa Gray defines a phyllodium as "a petiole usurping the form and function of a leaf-blade." In both cases, these definitions are intended to apply to the flattened leaf-substitutes of the Australian phyllodineous Acacias.* Bentham says of Division i., *Phyllodineae*—"Leaves all (except on young seedlings and occasionally one or two on young branches) reduced to *phyllodia*, that is to the petiole either terete or angular or more or less vertically dilated so as to assume the appearance of a rigid simple leaf, with an upper and a lower edge or margin, and two lateral similar surfaces, and either sessile or contracted at the base into a short petiole, the upper edge often bearing 1, 2, or rarely 3 or more shield-shaped or tubercular or depressed glands." (Fl. Austr., ii., p. 319.)

But the so-called phyllodes of the Australian phyllodineous Acacias are not simply flattened petioles which have lost their blades. The current statements about them, such as those quoted above, are imperfect generalisations based upon inadequate material. On the contrary, they are the flattened, primary leaf-axes or common petioles of bipinnate leaves which have lost their pinnæ; and it is the former which have usurped the form and function of the latter; and not flattened petioles which have usurped the form and function of leaf-blades. The so-called phyllodes of Australian Acacias may be long, or short, or very short. If long, they are the flattened primary axes, or common petioles, of potentially long bipinnate leaves, with numerous pairs of pinnæ. If short, or very short, they are the flattened primary axes, or common petioles, of potentially

*Gray's Botanical Text-book (1887), pp. 110, 426.

short, bipinnate leaves, with several, or only one pair of pinnæ, whose pinnæ have vanished. Therefore, as the so-called phyllodes of the Australian phyllodineous Acacias are not exactly comparable with the phyllodes of other plants, and are not phyllodes within the meaning of the current definitions thereof, they should be distinguished from ordinary phyllodes, and also have a distinctive name. As they are neither cladodes nor phylloclades, within the meaning of the current definitions of these structures, I propose to call them Euphyllodia or euphyllodes, in the sense that they are something more than is implied in the accepted definition of phyllodes; and, therefore, something more than simply flattened petioles; inasmuch as they really are, as I shall show, in what follows, vertically flattened, primary leaf-axes or common petioles, whose pinnæ have been suppressed, which have usurped the form and function of leaves. Instead of Phyllodineæ and phyllodineous Acacias, I propose to use the terms Euphyllodineæ and euphyllodineous Acacias, in order to be consistent.

Several more detailed interpretations of the phyllodes, so-called, of Australian Acacias are on record. One was offered by Morren, in 1852.* Unfortunately, no copy of this paper is available in Sydney, and I do not know on what kind of evidence he based his views. But two authors, Maxwell Masters and Baron von Mueller, have given the substance of Morren's hypothesis. Masters says§—"When the blade of the leaf is suppressed it often happens that the stalk of the leaf is flattened, as it were, by compensation, and the petiole has then much the appearance of a flat ribbon (phyllode). This happens constantly in certain species of *Acacia*, *Oxalis*, &c., and has been attributed, but doubtless erroneously, to the fusion of the leaflets in an early state of development and in the position of rest."

Baron von Mueller seems to have accepted Morren's hypothesis, but without mentioning the author of it. In his "Introduction to Botanic Teachings" (p. 25, 1877), he says of the Australian Acacias—"This enormous number of congeneric plants [about 300 species] can conveniently be separated into two main groups, according to the structure of their leaves, whether consisting of a simple blade, or whether formed by distinct leaflets. The first of this primary division is called that of the Phyllodineæ, from a Greek word implying leaf-like form, because the supposed simple leaves are in reality formed by the confluence of leaflets, stalklets and stalks into one leaf-like mass, or according to the more generally adopted but less accurate views simply dilated leaf-stalks (phyllodia); this metamorphosis is most readily demonstrated and proved by observing the apparently simple-leaved Acacias in early growth, when the first leaves developed by the young seedling will be found to be compound, consisting of leaflets arranged in two rows, thus forming pinnæ, several again of these pinnæ forming the *bipinnate leaf*, the axes along which the leaflets are placed being also arranged in a pinnate manner. What in the phyllodineous division of the genus Acacia is noticed only on the leaves of the young plant, becomes normal throughout for the second group, that of the Bipinnatæ."

A second interpretation is current in Textbooks of Botany. This is not less unsatisfactory than the Baron's. It is frequently presented as a brief, definite, and apparently authoritative statement—an axiom or a postulate, as it were, which the student is to accept in faith. For example, Bentham, in his generic description of *Acacia*, says—"Leaves twice pinnate or reduced to a simple

*C. Morren, Bull. Acad. Belg., 1852, t.xix., p.444.

§Masters, Vegetable Teratology, p.329, 1869.

phyllodium or dilated petiole" (Fl. Aust., ii., p. 301). Kerner says*—"It has already been mentioned on p. 335 [quoted later on for another reason] that a like modification of function occurs in many Australian Acacias, the foliage-leaves of which are devoid of green blades whilst the leaf stalks are developed as green, flattened, outspread organs, the so-called phyllodes." These, and similar statements are based on no more logical argument than this—The phyllodineous Acacias have phyllodes; phyllodes are flattened petioles, &c.; therefore the phyllodes of Acacias are flattened petioles, which have lost their blades. The fallacy of the argument lies in the fact, that the so-called phyllodineous Acacias have not phyllodes in the accepted meaning of the term.

Sometimes however, authors venture to give an explanation. But the explanations known to me are not less fallacious than the definitions of the phyllodes, so-called, of Australian Acacias. For example, Lubbock, in his "Flowers, Fruits, and Leaves" (p. 120, fig. 75: 1886) gives an explanation, together with an illustration of a seedling—the first ever published, as far as I know. He says "The typical leaves of Acacias are pinnate, with a number of leaflets. On the other hand, many of the Australian Acacias have leaves (or, to speak more correctly, phyllodes) more or less elongated or willow-like. But if we raise them from seed we find, for instance, in *Acacia salicina*, so called from its resemblance to a Willow, that the first leaves are pinnate (Fig. 75), and differ in nothing from those characteristic of the genus. In the later ones, however, the leaflets are reduced in number, and the leafstalk is slightly compressed laterally. The fifth or sixth leaf, perhaps, will have the leaflets reduced to a single pair, and the leaf-stalk still more flattened, while when the plant is a little older, nothing remains except the flattened petiole." Now the passage quoted is very remarkable, but hardly more so than others of similar import to be found in other books. Such statements are imperfect generalisations based upon inadequate material. Though put forward in good faith, they are nevertheless pitfalls and stumbling-blocks, both for teachers and students. The first statement that "the typical leaves of Acacias are pinnate" is faulty. There are no Acacias with pinnate leaves. On the contrary, the typical Acacias have twice pinnate or bipinnate leaves. Next, "But if we raise them from seed we find, for instance, in *Acacia salicina* . . . that the first leaves are pinnate (Fig. 75), and differ in nothing from those characteristic of the genus." The seedling shown in Fig. 75 has no pinnate leaf or leaves. The first is a bipinnate leaf with one pair of pinnæ, the second is also a bipinnate leaf with one pair of pinnæ, and with an indication of the so-called phyllode on the upper side; the third is also bipinnate with one pair of pinnæ, and indications of the so-called phyllode on both upper and lower sides; while the fourth and fifth are complete phyllodes, so-called.

Lubbock's description and figure of a seedling of *A. salicina* are the only ones of this species yet published. But if the seedling figured was not an anomalous one, it was an incomplete specimen; and Lubbock did not notice that the first leaf, which should have been a simply pinnate leaf, or perhaps a pair of opposite simply pinnate leaves, was missing. But what one particularly wants to know, is, why Lubbock calls the structure, to which the single pair of pinnæ of his bipinnate leaves is attached, the "leaf-stalk," which is firstly slightly compressed laterally, and then finally become the flattened petiole or phyllode? In other words, on what grounds is it taken for granted that the pinnæ of the

*Natural History of Plants, English Translation, Vol. i., p.637.

bipinnate leaves of Acacia-seedlings with only a single pair of them, which appear successively after the first simply pinnate leaf, or in some cases after an opposite pair of them, represent a pair of pinnæ at the node immediately above the leaf-stalk or petiole? I have not yet met with any description of Acacia seedlings or Acacias in which this question is answered, or even considered, except by Preston, referred to later on. As a matter of fact, the pair of pinnæ of bipinnate leaves, with only one pair, such as successively make their appearance after the first simply pinnate leaf, or a pair of them, represents the apical pair; and what is below them is the entire primary leaf-axis or common petiole, and not simply the ordinary petiole. That is to say, the succession of the pairs of pinnæ in the development of a bipinnate leaf with several pairs of pinnæ, of an Australian Acacia, is basipetal; and not basifugal, as tacitly assumed, and taken for granted.

It is interesting to note, therefore, how two eminent biologists, like von Mueller and Lubbock, independently came to the conclusion that, not merely the same sort of evidence, but the selfsame evidence—the evidence afforded by the "first leaves" of phyllodineous Acacia-seedlings—demonstrated and proved two divergent, and irreconcilable hypotheses: the metamorphosis of bipinnate leaves into phyllodes by the confluence of leaflets, stalklets and stalks in the one case; and by the flattening of the petioles and the disappearance of the blades, in the other. What is wrong with these two discordant conclusions is not that one is correct, and the other incorrect; but that neither of them is wholly correct, and that both are partially incorrect. Mueller's hypothesis is incorrect in so far as the leaflets and stalklets, that is the pinnæ, are concerned: for these abort entirely, and take no part whatever in the formation of the so-called phyllodes. The evidence on that point is clear and conclusive; and one is at a loss to understand how Morren and he were led to think that the leaflets and stalklets concresced with the stalks or axes. But the stalks, that is the primary axes, or common petioles of the actual or potential bipinnate leaves, the ordinary petioles together with the rhachises, do flatten to form the so-called phyllodes, and are the only components thereof; and, to that extent, his hypothesis is correct. But supposing that there is a confluence of leaflets, stalklets and stalks, why was Mueller content to call such structures phyllodes, when, by the current definition, phyllodes are flattened petioles, which have lost their blades—neither more nor less?

On the other hand, Lubbock's hypothesis is incorrect in supposing that, in the formation of Acacia phyllodes, so called, "nothing remains except the flattened petiole"; whereas, in truth, everything remains except the pinnæ. But it is correct in so far as the pinnæ are concerned, for these vanish entirely.

While lack of adequate material, and of personal knowledge of the plants as they grow under natural conditions, are the ultimate reasons for the long-standing, incorrect, current ideas about the phyllodes, so-called, of Australian Acacias, there are three main proximate reasons:—

(1) The ambiguous, because too general, statements about the "first leaves" of the seedlings of the Australian phyllodineous Acacias; and the neglect to determine the mode of the succession of the pairs of pinnæ in the development of the bipinnate leaves.

(2) Either the non-recognition of the presence of the "*seta terminalis*" of Bentham, or "the recurved point," or the "excurrent point" of the common petiole or of its distal component, the rhachis; or, if noticed and mentioned, the disre-

gard of its meaning and significance, when discussing the nature and interpretation of Acacia-phyllodes, so-called.

And (3) The omission to take into account the simple but very significant fact, that the petioles, or apparent petioles of all the known Australian bipinnate Acacias, of which twenty-two species are described by Bentham in the Flora Australiensis, are short or even very short, relatively to the length of the entire, primary leaf-axes, or common petioles; whereas some Acacia-phyllodes, so-called, are not only much longer than the petioles of any existing bipinnate Australian Acacia, being as long as 12 to 20 inches in some species; but are even longer than the common petioles of the longest leaves of any known, bipinnate, Australian Acacia.

I propose, therefore, to consider these three questions seriatim, and in some detail, because it is time the real nature of the so-called phyllodes of Australian Acacias was recognised and taken into account. The current belief about them is a barren conception, which has obstructed the progress of knowledge, and leads one into the wilderness. If the so-called phyllodes of Australian Acacias are simply flattened petioles which have lost their blades, there is nothing more to be said about them that is of any importance. But when one knows what they really are, it is a simple matter to reconstruct the euphyllodineous Acacias, and, then having done this, to find corresponding analogues among the existing, bipinnate species. And not only so, but when one knows where, when, and how to look for reversion-foliage and reversion-shoots of the right sort, one can find Nature actually reconstructing them, as I shall presently show. Having arrived at this stage, the study of the euphyllodineous Acacias takes on an entirely new, and extremely interesting and promising aspect.

The "First Leaves" of the Seedlings of Australian Acacias.

From the extracts given above, it is evident that, by the expression the "first leaves" of Acacia-seedlings, Mueller and Lubbock mean—and the same remark will apply to other authors who express themselves similarly—the earliest leaves which successively develop on young seedlings; and that neither of them takes account of the simply pinnate leaf, or sometimes a pair of opposite, simply pinnate leaves, which is, or which are, actually the first to appear.

The foliage of the young seedlings of the Bipinnatæ is similar to that of other plants with bipinnate foliage, in that the earliest leaves to make their appearance are of a simpler type than those which follow them in later stages of the development of the complete bipinnate leaf. The march of progress, as is usual, is from simple to complex.

The very first leaf is an abruptly pinnate leaf, with several pairs of leaflets, or there may be an opposite pair of them. The second is an abruptly bipinnate leaf with one pair of pinnæ and more or less numerous pairs of leaflets. Now this leaf, and others like it, which follow, represents and corresponds to a leaf like the first, in which the apical pair of leaflets has been replaced by an apical pair of pinnæ; while the lower pair, or pairs, of leaflets, counting from above, have been suppressed. That this is the correct view to take is shown by the presence of the *seta terminalis*, or terminal seta, in which the primary leaf-axis terminates in both cases. This is the remnant of a terminal leaflet in the first, abruptly pinnate leaf; and the remnant of a terminal pinna in the abruptly bipinnate second leaf, and in others like it, as will be discussed more in detail later on.

In seedlings of *A. discolor*, one of the very common bipinnate Acacias of the Sydney district, for example, the first leaf is abruptly pinnate with about six pairs of leaflets; the second, third, and fourth may be bipinnate with seven pairs of leaflets on the second and third, and twelve pairs on the fourth. The fifth, sixth, and seventh may be bipinnate, with two pairs of pinnæ; these correspond to a leaf like the first, in which the apical pair of leaflets, and the pair next below, have been replaced by pairs of pinnæ. The eighth leaf may have three pairs of pinnæ; this corresponds to a leaf like the first, in which the apical pair of leaflets, and two pairs next below, have been replaced by pinnæ. After the eighth the number of pinnæ may increase by one pair more or less consecutively in succeeding leaves, until something approaching the maximum is attained. In one seedling however, and the only one seen, the third leaf had two pairs of pinnæ. In seedlings of other species, the number of pairs of pinnæ increases sometimes a little sooner, sometimes a little later, much in the same manner as described above in *A. discolor*. The terminal seta, unless accidentally missing, terminates the common petiole of every leaf, at every stage of growth. Therefore, the mode of succession of the pairs of pinnæ in the gradual development of the bipinnate leaf is basipetal, and not basifugal, as has hitherto been tacitly assumed and taken for granted in every case that has come under my notice.

The primary leaf-axis of the first, abruptly pinnate leaf may be slightly longer than that of the second bipinnate leaf with one pair of pinnæ, but the latter have more than twice as many leaflets. As the number of pinnae increases, the axis lengthens proportionally, until it reaches its final dimensions. When the maximum number of pairs have been developed it will be noticed that the petiole is relatively short.

Young seedlings of the Euphyllodineæ, old enough to show the transition from bipinnate leaves to euphyllodes, are very interesting and instructive. They are the embodiment, and, at the same time, the visible presentment or picture of an intense struggle between two antagonistic tendencies or forces. On the one hand, the hereditary tendency to produce the ancestral type of foliage makes a start in the normal way. The first leaf is an abruptly pinnate leaf, or, in some species, there may be an opposite pair of them. The second leaf is an abruptly bipinnate leaf with one pair of pinnæ, just as in the seedlings of the Bipinnatæ. Very soon, somewhat sooner in some species than in others, the antagonistic tendency, the euphyllode-producing tendency, nowadays also an inherited tendency, manifests itself, and, after a few preliminary stages, the usurper succeeds in swamping the natural tendency to continue the production of bipinnate foliage. This commonly, but not always, happens before the seedlings are strong enough to enable the bipinnate leaves to develop a second pair of pinnæ; and, in such species, the second, third, fourth, fifth leaf or some later one may be the earliest complete euphyllode.

The object of the struggle is to get rid of the pinnæ, whose leaflets are the transpiring and assimilating organs proper, and to substitute for them the vertical, flattened, leaf-like leaf-axes or common petioles, or euphyllodes, capable of taking over and carrying out the functions of the leaflets on a more economical basis for regulating the water-supply and expenditure. It is important to realise this; and that the contest is not between flattening, ordinary petioles, and leaf-blades, which are to vanish. Now a substitutional structure, and a structure for which a substitute is being provided, cannot completely coexist and function in all respects simultaneously. In the case of the substitution of euphyllodes or flattened leaf-axes for pairs of pinnæ, from the nature of the case, the substitution or replacement cannot take place instantaneously in a flash, but only by gradual, intermediate stages. It necessarily follows, therefore, that some indication of both can and may be present at the same time, but in an inversely proportional ratio. If the pinnæ are strongly in evidence, after the struggle begins, the euphyllode will be only slightly indicated; whereas if the euphyllode is strongly in the ascendant, but not yet complete, the pinnæ will show signs of some kind or other that they are on the wane. The swamping, euphyllode-producing tendency usually acts too promptly in young seedlings to show the inversely proportional relations between the two contestants very satisfactorily. But good examples of reversion-foliage, and the leaves of reversion-shoots show them most beautifully and convincingly.

Sir John Lubbock, afterwards Lord Avebury, in his great book "On Seedlings" (1892), mentions or describes, or describes and figures seedlings of seven species of Acacia. But his material was very limited, and sometimes restricted to a single seedling. It is remarkable that the species, whose seeds he was able to get, are all out-of-the-way or inland species, and do not include a single example of our common and familiar species. Lubbock was interested in them as seedlings merely; and it was not his object to discuss the nature of the euphylodes of those that were euphyllodineous species. Having complete seedlings at his disposal, he was able to recognise, this time, that the first of six of them was an abruptly pinnate leaf. But of two species, not figured, *A. Oswaldi* and *A. acanthocarpa* he says—"Leaves compound and abruptly pinnate or reduced to phyllodes," and "First leaves compound, abruptly pinnate"; but as he makes no mention of the presence of bipinnate leaves in either case, one does not know how to take these statements, since his descriptions of the seedlings of these two species are all that are available at present. On the other hand, he describes the first six leaves of a seedling of *A. Burkitti* as bipinnate. This is the only Acacia-seedling, without an abruptly pinnate first leaf, or a pair of them, yet recorded. Lubbock also recognises the presence of Bentham's terminal seta in the seedlings of two species, but unfortunately he locates it on the petioles. Thus, of the first six leaves of *A. Burkitti*, all bipinnate with one pair of pinnæ, he says "petiole excurrent between the pinnæ, with a subulate slender point." Also of *A. verticillata* he says—"Leaves at first pinnate then bipinnate, then reduced to phyllodes . . . petioles laterally compressed . . . and projecting beyond the pinnæ with a subulate acute aristate point." The petiole of a compound leaf is the portion of the common petiole, or primary leaf-axis, below the lowest pair of pinnæ; therefore, all the pinnæ are attached to the rhachis; consequently it is the common petiole, or its distal component, the rhachis, which terminates in an excurrent point or terminal seta. If the petiole terminates in an "excurrent point," then, since the latter is above the pair of pinnæ, these must be attached to the petiole—which is absurd. He correctly adds, however—"rhachis of pinnæ excurrent in the form of a small subulate point." And he should have said—common petiole, or the rhachis which is its distal component, with an excurrent point. But, accepting the current idea, that the phyllodes of Acacias are simply flattened petioles, he tacitly assumed and took for granted, as he did in the earlier passage quoted above, that the single pair of pinnae of his bipinnate leaves was the lowest or basal pair, whereas it is the apical or uppermost pair which appears first; and that the stalk to which the pinnæ were attached was the petiole, whereas it was the common petiole or primary leaf-axis, as is proved by its terminating in an excurrent point or terminal seta.

Mr. R. H. Cambage has recently taken up the study of Acacia-seedlings where Lubbock left off; and, from his extensive knowledge of the Australian flora, and of Acacias growing under natural conditions, he is eminently qualified to undertake it. Since 1915, he has published five instalments of a monograph on "Acacia-Seedlings," which include descriptions and excellent photographs of the seeds, pods, and young seedlings of fifty-five species. This is an excellent beginning of a very important contribution to knowledge, which can only be done properly as he is doing it, with personal knowledge of the plants under natural conditions, and with adequate material. As it is necessarily a leisure-time study, he deserves, in an especial manner, all the encouragement and help that we can give him. If he will take into consideration the evidence I am now bringing forward, and will modify his terminology accordingly, I venture to predict that his work will become more inspiring and interesting even than it has been.

Cambage's papers and illustrations show admirably, how promptly the swamping effect of the usurping, euphyllode-producing tendency takes place in all the euphyllodineous species he has described, with the exception of *A. melanoxylon*. This is one of a small group of exceptional species, which includes *A. rubida*, and apparently also the non-Australian species, *A. heterophylla*, that is in need of special and detailed study of good series of gradational stages.

The transition from an abruptly pinnate leaf, or more usually from a bipinnate leaf with one pair of pinnæ, or sometimes two pairs, to the first complete euphyllode, of seedlings of the euphyllodineous Australian Acacias, may take place on any leaf, from the second to the ninth, or even later, according to the species, and according to circumstances. The difference in seedlings of the same species is mainly due to the absence or the presence of lingering stages of the dwindling pinnæ. It is usually, but not invariably, complete before the seedlings are able to develop leaves with two pairs of pinnæ. Cambage has found it to be the second leaf in *A. alata* (not counting the members of the opposite first pair of simply pinnate leaves separately), in about a dozen specimens, so that no bipinnate leaves with one pair of pinnæ had a chance to develop. He has also found it to be the third leaf sometimes in *A. excelsa*. In the seedling figured by me (Pl. ii., fig. 2) it is the fourth leaf. This is the seedling of the species (probably *A. implexa*, as Mr. Cambage has been good enough to advise me) which has furnished me with my best and most instructive reversion-shoots and suckers, because the euphyllodes are so long, up to about 9 inches. I was not interested in the plants before they were scorched, and the portions of the plants above ground killed, but without damage to the root-system, by a bush-fire, or in some cases injured in other ways; and there has not been time yet for the new shoots to flower; and I have been unable to find adult, uninjured plants in a condition suitable for exact identification of the species. In the seedling shown, the first abruptly pinnate leaf had three pairs of leaflets, but the apical pair, and one of the next pair below, were missing, when I got the specimen. The second, third, and fourth are bipinnate, with only one pair of pinnæ in all of them. One pinna of the second is damaged, and is represented by one leaflet and a portion of its fellow. Above what remains of the damaged pinna in the position shown, the terminal seta at the apex may be seen in the photograph of the common petiole, projecting to the left. The fifth is a short, relatively broad, complete euphyllode, $2\frac{3}{8}$ inches long; the sixth is longer but narrower; the seventh is still longer; the eighth (bent in the photo) is $7\frac{5}{16}$ inches long. An average sample of a complete euphyllode from a reversion-shoot, $8\frac{3}{4}$ inches long, is shown beside the seedling on the left. My reversion-shoots show fifteen later stages that are skipped in this seedling, to be referred to later on.

Of sixteen bush-seedlings of *A. falcata,* the first complete euphyllode was the fifth leaf in nine, the sixth in six, and the seventh of one; the leaf immediately preceding the first complete euphyllode in each of two seedlings had two pairs of pinnæ. Of sixteen bush-seedlings of *A. myrtifolia*, the first complete euphyllode was the fifth of two, the sixth of seven, the seventh of six, and the eighth of one; seedlings of this species also sometimes have one, and occasionally two leaves with two pairs of pinnæ. Seedlings of *A. linifolia,* of which the first complete euphyllode may be the sixth-ninth, may also have one leaf, or two leaves, or, as in one of my specimens, three leaves, with two pairs of pinnæ. The leaves of seedlings of *A. suaveolens* often show most interesting lingering stages of dwindling pairs of pinnæ, the last of which may be represented by only a single pair of leaflets, with the terminal seta at the apex of the rhachis; and this is quite as conspicuous at the apices of the succeeding euphyllodes. Further details will be found in Cambage's papers.*

The Terminal Seta or Recurved Point of the Bipinnate Leaves and Euphyllodes of Australian Acacias.

No. 3 of the definitions given in Bentham's paper on the Mimoseæ, referred to later on, is very important, namely—"A small point terminates the petioles whether common or partial, in all or nearly all *Mimoseae.* It is usually setiform, though sometimes short and thick, and occasionally almost foliaceous, sometimes apparently continuous with the petioles [*i.e.*, the common or partial petioles as defined on p 324; but not petioles in the sense in which some later authors use the term, following Kunth], at other times falling readily off. This point has by some been termed a gland; but, it would appear, erroneously. It may possibly be the rudiment of a terminal pinna or leaflet; but as there is no evidence beyond its position [*i.e.*, terminating the common or partial petioles] to shew that it is so. I have been unwilling to give it any other name than *seta terminalis*."

Now this was written some seventeen years before the publication of Darwin's "Origin of Species." Chapter xiii., of the "Origin" deals, in part, with the subject of Rudimentary Organs. Darwin's treatment of the subject gave an altogether new view of the importance and significance of rudimentary organs and vestigial structures. To-day, remnants and vestigial structures mean very much more to the morphologist than they did seventy-eight years ago. Then, Bentham knew of "no evidence, beyond its position," to say more than that the *seta terminalis* was possibly "the rudiment of a terminal pinna or leaflet." To-day, I imagine, no one qualified to speak, will take exception to the statement that it really is, what Bentham, seventy-eight years ago, said it possibly might be. The *seta terminalis* of the pari-pinnate leaf of *Cassia Candolleana*, for example, a common garden plant, or of the pari-pinnate first leaf of Acacia-seedlings, undoubtedly represents the remnant of an aborted terminal leaflet, corresponding to the terminal leaflet present in *Robinia pseudacacia,* for example; just as, in the bipinnate foliage of seedlings or of the adult plants of the Bipinnatae, or in the bipinnate foliage of seedlings, on the young euphyllodes, and frequently on the adult euphyllodes of the Euphyllodineæ, unless accidently missing, it repre-

* Cambage, "Acacia Seedlings." Parts i.–v. Journ. Proc. R. Soc. N.S.Wales, Vols. xlix.–liii., 1915-19.

sents the remnant of a vanished terminal pinna corresponding to the terminal pinna of the impari-bipinnate leaves of *Caesalpinia Gilliesii.* (Pl. ii., fig. 1).

Moreover the *setae terminales* of the reversion-foliage of *A. suaveolens* are sometimes green and foliaceous, like incomplete leaflets or a pair of leaflets (Pl. i., figs. 4, 8, 9, 10); and the leaves of reversion-shoots of *A. implexa* (?) and *A. podalyriaefolia* sometimes have thread-like rudiments of the axes of the terminal pinna present, without leaflets, but with a terminal seta at the apex (Pl. viii. 5, 6).

Admittedly, the *seta terminalis* is of no practical importance to the describer of species. Nevertheless, in his paper on the *Mimoseae,* almost all the species of which have bipinnate leaves, Bentham took the trouble to discuss what he conceived to be its meaning and significance. It was unfortunate, therefore, that, when he came to deal with the Australian Acacias in the second volume of the Flora Australiensis, especially as the euphyllodineous species far outnumber the bipinnate species, he took no account of the *seta terminalis,* as defined in the paper on Mimoseæ, or of its significance, except that he merely mentions its occurrence, under another name, the "recurved point," in two only of the twenty-two species of Bipinnatæ which he describes, as if these were the only two species in which it was to be found. Thus of *A. polybotrya* he says—"the rhachis terminating in a recurved deciduous point" (p. 414); and of *A. leptoclada*—"Pinnæ 3-5 pairs, 3-4 lines long, on a common petiole of ¼ to ½ in., ending in a recurved point" (p. 416).

But the recurved point, or *seta terminalis,* unless it is accidentally missing, is usually equally constant and significant, not only in other bipinnate Acacias in which no mention is made of its presence; but also on the leaves of seedlings of the *Euphyllodineae,* and at the apices of euphyllodes, especially in the young stages. Bentham furnished descriptions of 271 species of euphyllodineous Acacias. It is remarkable, therefore, that the *setae terminales* of some of them did not attract his notice, or arouse his suspicion that the so-called phyllodes of Acacias were something more than merely flattened petioles.

Kerner is the only author known to me† who rightly recognises that there is a vestigial structure at the apex of the so-called phyllodes of Acacias, which, in reality, is Bentham's *seta terminalis,* in which the common petiole, or the rhachis, its distal component, terminates: but not the petiole, as Lubbock expressed it.—Thus he says—"In many of the vetches of the Southern European flora (*Lathyrus, Nissolia, Ochrus*) but especially in a large number of Australian shrubs and trees, principally acacias (*Acacia longifolia, falcata, myrtifolia, armata, cultrata, Melanoxylon, decipiens,* etc.) it is the leaf-stalks which are extended like leaves placed vertically, and then the development of the leaf-lamina is either entirely arrested, or has the appearance of an appendage at the apex of the flat, green leaf-stalk or "phyllode" as it is called."* As far as the Acacias are concerned, the appendage at the apex of the "phyllodes," here referred to, is simply Bentham's *seta terminalis,* or recurved point, the rudiment of an arrested terminal pinna, in which the common petiole, or its distal component, the rhachis, terminates. It is not, as Kerner supposes, under the influence of the current dogma, that Acacia-phyllodes, so-called, are simply flattened leaf-stalks or petioles, the remnant of an arrested leaf-lamina. The pinnæ only have been arrested, and not the rhachis as well. Consequently, the terminal seta retains its normal position at the apex of the rhachis, that is, the apex of the common petiole, or the primary axis of

* Natural History of Plants, English Edition, Vol. i., p. 335.

† But see the reference to Goebel's views *postea,* p.44.

the leaf. But that Kerner should be the only author, so far as I can learn, to have recognised the occurrence of an apical, vestigial structure on the so-called phyllodes of the Australian Acacias, is both surprising and interesting. His mistake, like the mistakes of others, was attributable to a lack of adequate material for study. Nevertheless, his observation is notable.

The meaning and significance, and in some cases the occurrence, of the terminal seta or recurved or excurrent point, or rudiment of the terminal pinna, of the leaves of the Australian Acacias, whether in the seedling-stage or otherwise, have received such scant consideration from authors, that a comparison of the leaves of Acacias with those of other genera with remarkable bipinnate leaves is not only very instructive, but what can be learned in this way needs to be emphasised and allowed for.

For comparative purposes, the most satisfactory material is afforded by the leaves of three plants belonging to exotic genera, more or less common in gardens in Sydney. I am unable to find anything about them in any books available to me, from the particular standpoint in which I am interested in them. These are *Caesalpinia Gilliesii* Wall., native of La Plata States, which is of interest because the leaves have a terminal pinna, but the pinnæ lack a terminal leaflet; *Jacaranda ovalifolia* R.Br., native of Brazil, which is remarkable because the leaves have a fugacious terminal pinna which is wanting in the mature leaves, the pinnæ have a terminal leaflet, and the mode of succession of both the pinnæ and the leaflets in the development of the bipinnate leaf is basifugal; and the West Indian *Calliandra portoricensis,* whose leaves, like those of the bipinnate Acacias, have neither a terminal pinna, nor have the pinnæ a terminal leaflet; but, in both cases, especially in the young leaves, unless it is accidentally missing, the terminal setæ are conspicuous.

C. Gilliesii has leaves up to nearly 7 inches long, to the base of the terminal pinna; with twelve or thirteen pairs of short pinnæ, with about eight to ten pairs of leaflets. As in the Acacias, the leaves present anomalies. Some of the pinnæ are alternate instead of opposite; one of a pair is sometimes missing; the terminal pinna is occasionally missing; the number of pairs of leaflets of the pinnæ is variable. The leaves show:—(1) that the internodes are about as long as the spread of an expanded pair of leaflets, measured from tip to tip across the partial rhachis; (2) that the pinnæ of the lower pairs are fairly at right angles to the axis, but that the apical pair and several pairs next below do usually move inwards slightly, so that there may be some slight overlapping of the lower leaflets of the apical pair and the terminal pair, even though the latter has a longer petiole than the others; (3) and that the petiole may be no longer than the lowest internode, or half as long again; but however much it may be, it is but a small fraction of the length of the entire axis or common petiole. Fig. 1 of Pl. iii., represents the upper portion of a leaf, in which the pinnæ of the apical pair are at right angles to the axis; and this was chosen for illustration because the terminal pinna was fully displayed. Lubbock figures a very young seedling of this species, with only the first leaf, which is abruptly pinnate, but no further particulars are given.

The longest Jacaranda leaf that I have, without portion of the tip, which is missing, is 21½ inches long, petiole 2¾, with 32 pairs of pinnæ, some of which are alternate. Longer leaves may be seen on some trees. Mature leaves rarely show anything at the apex, but the basal scar of something which is missing. I figure a small leaf from a young plant 8¾ inches long, which should have eighteen pairs of pinnæ and a terminal pinna; but the terminal pinna, and four pairs of pinnæ are represented by large leaflets, some of them with serrated edges. I have also other leaves showing more advanced, but still, incomplete transformations. On the other hand, one can get examples in which the terminal pinna is present, but the leaflets are not expanded. In this condition, it is apt to be fugacious; and one often finds only a withered or broken remnant of it. The basifugal succession of both the pinnæ and the leaflets in the development of the bipinnate leaves is very interesting. The pinnæ in the basal region are usually short; in the middle region they are very long, with numerous pairs of pinnæ, and a terminal leaflet. The internodes may be as long as, or shorter than the spread of an opposite pair of expanded leaflets. The petiole is relatively very short, as long as about two or three, or more, internodes, if some of the possible lowest pinnæ do not develop. The variable length of mature leaves on the same plant, that is the variable number of the pairs of pinnæ present, is, I think, attributable to accidents, at different stages of growth, to the apical portion of the leaves before the basifugal development of the full number of pinnæ is complete.

The leaves of *Calliandra* have up to six or seven pairs of pinnæ. As in the bipinnate Acacias, the terminal pinna, as well as the terminal leaflet of the pinnæ, has been arrested; but, in both cases, their remnants, the terminal setæ, are present, unless accidentally missing, and are especially noticeable in young leaves. Of a leaf with six pairs of pinnæ, the length of the common petiole was $3\frac{1}{8}$ inches; the spread of a pair of opposite expanded leaflets $\frac{11}{16}$, or about the length of two internodes; and the length of the petiole $2\frac{1}{16}$. The petioles of these leaves, proportionately to the length of the common petioles, are the longest I have met with; and the length of the internodes is less than the spread of an opposite pair of leaflets; but this causes no overlapping as the apical pair of pinnæ, and one or two pairs below them move upwards and inwards, and the basal pair move downwards and inwards.

The youngest leaves of *A. discolor* that one can get, show excellently the terminal setæ both of the common petiole and of the pinnæ (Pl. viii., fig. 2). Also that there is no addition of pinnæ at the apex of the leaf, after the lowest pinnæ are developed, as in *Jacaranda*. All the pinnæ that are to be present in the mature leaf, are represented in the primordium of the leaf; and when the pinnæ of the young leaves move into place, and the leaflets expand, the pinnæ are all equally developed. Similar statements are applicable to the very young leaves of *A. decurrens*.

Fig. 2 of Pl. iii., shows the leaf of a seedling of this species, with three pairs of pinnae, the middle pair of which illustrate the incomplete basipetal development of the leaflets.

Due recognition of the meaning and significance of the terminal setæ of the leaves of the bipinnate Acacias, and especially of the leaves of seedlings with only one pair of pinnæ, is the key to the understanding of euphyllodes. Whatever else may be wanting, the apical pair of pinnæ is always present, unless accidentally missing, except in decadent stages such as are shown in Plate vii.

The Petioles of the Leaves of Bipinnate Australian Acacias

The euphyllodes of some Australian Acacias are very long, from 12-20 inches. In considering the nature of such remarkable developments as these, it is necessary to consider some of the characters of the leaves of the bipinnate Acacias, and especially of their petioles.

Seventy-eight years ago, Mr. Bentham monographed the species of *Mimosa.* He began his paper by formulating some definitions.* Thus he said—"Before entering into descriptive details, some preliminary explanations may be necessary relating to some of the terms used in characterising *Mimoseae,* and applied by different writers in different senses. . . . I have uniformly adopted the phraseology usually followed by De Candolle, giving the name of *pinnae* to the primary divisions, and of *foliola* to the ultimate divisions [of the bipinnate leaf]. . . . I have also designated by *petiolus communis,* the *whole* of the stalk to which the pinnae are affixed, not (as is done by Kunth), that part only which is below the lowest pair of pinnæ, and by *petiolus partialis* I have meant the whole of the stalk to which the foliola are attached." Accordingly, in this paper, Bentham refrains altogether from using the terms petiole and rhachis.

The adoption of the term common petiole, in the sense defined, has the advantage of avoiding a possible difficulty—namely, if the portion of the common petiole of a bipinnate leaf below the lowest pair of pinnae, the petiole in the Kunthian sense, is longer than the internode immediately above, how is one to be quite sure that at least one pair of pinnæ, below the lowest pair present, has not been suppressed; and that, consequently, the supposed petiole is only apparently, and not really, the actual petiole?

When Bentham came to deal with the Acacias in the second volume of the Flora Australiensis (1864), he adopted a somewhat different and mixed terminology, partly as defined above for the *Mimoseae* proper, and partly in accordance with the definitions given in the Introduction and Glossary prefixed to the descriptive matter in the first volume. While still using the term common petiole for the whole of the stalk to which the pinnæ are affixed, he also uses the term petiole, in the Kunthian sense, for that part which is below the lowest pair of pinnæ; and he also uses the term rhachis. But I do not understand Bentham to use the term common petiole as synonymous with the term rhachis, as defined in the Introduction—"39. The common stalk [of a compound leaf] upon which the leaflets are inserted is called the *common petiole* or the *rhachis.*"

If one examines the impari-pinnate leaves of *Tecoma capensis* (4 pairs), *T. radicans* (4-5 pairs), *Robinia pseudacacia* (8 pairs), *Ailanthus glandulosa* (up to 14 or more pairs)—all common garden-plants, with leaves of the same type, varying considerably in length according to the number of the pairs of leaflets, with fairly large leaflets, much about the same breadth—it may be noticed: (1) that the length of the internodes corresponds to, or is a little longer than the greatest breadth of the leaflets, so that these may be fully exposed to the light without any overlapping; (2) that the leaflets are fairly at right angles to the axis to which they are attached; (3) that by the lengthening of the petiole of the terminal leaflet, this also is fairly displayed without overlapping the leaflets of the pair next below; and (4), that the petioles—the portions of the common petioles below the lowest pair of pinnæ—are relatively short or very short, no longer sometimes than the lowest internode, or half as long again, or a little longer.

If, next, one examines the pari-pinnate leaves of *Cassia Candolleana,* also common in gardens, with four pairs of leaflets, it may be noticed:—(1) that the internodes are about as long as, or a little longer than, the greatest width of the leaflets; (2) that, in the absence of the terminal leaflet, the leaflets of the first pair, or of the first and second pairs next below, usually move slightly inwards,

* Bentham, "Notes on *Mimoseae*, with a short Synopsis of Species." Hooker's Journal of Botany, Vol. iv., p. 342, 1842.

while the two still lower pairs are more or less at right angles to the axis; (3) that there is a terminal seta representing a remnant of the missing terminal leaflet, unless it is accidentally wanting, as it often is in the full-grown leaves, which is green and very conspicuous in quite young fresh leaves; and (4) that the petiole, real or apparent, is somewhat variable in length in different leaves, and may be about half as long again as the lowest internode, or even a little more.

In the pari-bipinnate leaves of the Australian Acacias, it will be noticed—(1) that, in the absence of the terminal pinna, represented by the terminal seta, the pinnæ of the apical pair invariably, as far as I have seen, move inwards so as almost or actually to touch or even slightly overlap; that those of a few pairs below, if the pairs are numerous, may also move inwards, but that some of the lowest pairs may be more or less at right angles;—(2) that the internodes are about as long as the spread of an opposite pair of expanded leaflets measured from tip to tip, but may be slightly longer; the internodes of the same leaf may also vary slightly in length—and (3) that the petioles, apparent or real, are short if the leaflets are short, excessively short sometimes as in *A. Baileyana,* and *A. Jonesii,* but much longer, though still relatively short, if the leaflets are long as in *A. pruinosa,* or very long indeed, as in *A. elata.* Following are the measurements of the leaves of the five species available:—

A. Baileyana—4 pairs of pinnæ; common petiole, $1\frac{1}{8}$; lowest internode, $\frac{1}{4}$; petiole, $\frac{1}{8}$ inch. (Pl. iv., fig. 1). The largest number of pinnæ noticed is five pairs. The leaflets of this species are not sensitive.

A. discolor—9 pairs of pinnæ; common petiole, $4\frac{1}{2}$; lowest internode, $\frac{5}{16}$; petiole, 1 inch. In another leaf on the same branch, the petiole was no longer than the internode above.

A. decurrens—17 pairs of pinnæ; common petiole, $5\frac{1}{4}$; lowest internode, $\frac{1}{4}$; petiole, $\frac{7}{8}$ inch.

A. pruinosa—6 pairs of pinnæ; common petiole, $6\frac{7}{8}$; leaflets up to $\frac{3}{4}$; lowest internode, $\frac{7}{8}$; petiole, $1\frac{5}{8}$ inch.

A. elata—5 pairs of pinnæ; common petiole, $9\frac{3}{4}$; leaflets up to $1\frac{5}{8}$ (Bentham gives up to 2 inches); lowest internode, $1\frac{3}{4}$; petiole, $2\frac{3}{4}$ inches. Three other leaves have the petioles somewhat shorter. This species has very long pinnæ, up to more than 8 inches.

Bipinnate leaves may be short, or long, or of intermediate length, according to the number of pairs of pinnæ present; that is, according to the number and length of the internodes, and the length of the apparent petiole. The number of pairs of pinnæ present in a given length depends on the length of the leaflets, and this is a very variable quantity.

The bipinnate leaves of *A. elata* and *A. pruinosa,* of all the twenty-two species described in the Flora Australiensis, and as described therein, have the longest leaflets. Therefore, they may be expected to have, as they actually have, the longest internodes, and the longest petioles, real or apparent. No seedlings of euphyllodineous Acacias have as yet, been described by Cambage, with leaflets promising to be anything like as long as those of *A. elata.*

Allowing about 3 inches as the maximum length of the petioles of the Australian bipinnate Acacia with, by far, the longest leaflets known, what valid ground is there for supposing, if the so-called phyllodes are simply flattened petioles which have dropped their blades, that they can attain lengths of "from 6 in. to 1 ft." (*A. macradenia*), "above a foot long, the upper ones $\frac{1}{2}$ ft." (*A.*

cyanophylla), "lower phyllodia 6 to 10 in. long" (*A. Lindleyi*), "3-10 in. long or even more" (*A. pachycarpa*), and others, as described by Bentham? I have euphyllodes of *A. longifolia* up to 13½ inches long, and 1½ broad; and Maiden has recorded a variety of this species with phyllodes, so-called, up to 20 inches long. Allowing one-third of the total length for that of the petioles, euphyllodes 12-20 inches long—if they are simply flattened petioles which have lost their blades—should belong to potential bipinnate leaves 3 to 5 feet long!

The euphyllodes of Australian Acacias may be short or they may be long. If very short, they are the flattened axes of species, which, if they had not become euphyllodineous, would have only a few (1, 2, or 3) pairs of pinnæ. If long, under similar circumstances, they should have numerous pairs of pinnæ, as shown in my photographs (Pls. v.-vii.) of leaves of reversion-shoots of a species with long euphyllodes, up to 8¾ (Pl. ii., fig. 1) inches long, or even longer. But flattened petioles of leaves of Australian Acacias, which have lost their blades, as long as 12-20 inches, are mythical structures; and the idea that there are, or may be such is nothing less than fantastic!

The current idea that the euphyllodes of Australian Acacias are simply flattened petioles which have lost their blades, is a barren conception which has retarded the progress of knowledge. If that is all they are, one is precluded from discussing the question of what sort of bipinnate Acacias the euphyllodineous Acacias would or might be if they did not develop euphyllodes.

But when it is realised that the euphyllodes are the flattened, primary leaf-axes or common petioles of bipinnate leaves which have lost their pinnæ, it becomes possible to reconstruct them theoretically in a very simple way, and then to find analogues of them among the existing Bipinnatæ, since these include Acacias of which the adult leaves have—one pair of pinnæ only, "on a common petiole of about ½ inch long," as Bentham records of *A. Gilberti*, or "1 or 2 pairs, the common petiole about ¼ inch" (*A. suberosa*), or any number of pairs up to "usually 10 to 20 pairs" (*A. dealbata*, length of common petiole not stated), or "15 to 20 pairs, the common petiole 2 to 3 inches" (*A. Bidwilli*), or possibly even more, if one were to search carefully over abundance of material.

The simple method of reconstructing them is, to measure with a pair of compasses the length, from tip to tip across the partial rhachis, of a good pair of opposite, expanded leaflets on the bipinnate leaves of a seedling. This will give approximately the length of an internode. Then measure off the internodes on a euphyllode, beginning at the apex, and what is over, regard as the petiole. This will enable one to calculate approximately the possible number of pairs of pinnæ that could be present. If one can get a seedling with a leaf with two pairs of pinnæ, one can compare the length of the internode with the length of an opposite pair of leaflets. Having done this, then look for the bipinnate analogue among the bipinnate species described by Bentham, or others, and figured in Mueller's "Iconography of the Acacias," or elsewhere. But, of course, reversion-foliage, and especially reversion-shoots, if one can get good specimens, will show Nature's method of actually doing it.

Reversion-Foliage, Reversion-Shoots, and Suckers.

Textbooks sometimes mention, in an indefinite way, the occurrence of reversion-foliage on euphyllodineous Acacias which have been pruned or otherwise injured. Lubbock and Thomé's figure sprays of *A. melanoxylon*, with both euphyllodes and bipinnate leaves; and other authors mention similar peculiarities. This species is an exceptional one, in need of special investigation. It is a species which I have not had the opportunity of examining. *A. longifolia* is much infested by borers, and one can find plants which have been broken by people in getting the flowers, but I have never met with reversion-foliage. Seedlings of *A. falcata* are often so badly attacked by insect gall-makers, that the growing point may be killed, but I have not found that it induces the production of reversion-foliage. Plants of *A. myrtifolia* often show a disorganised production of crowded euphyllodes, apparently due to fungoid attacks, but I have failed to find reversion-foliage.

Quite the most satisfactory species for foliage of this kind is *A. suaveolens*, because one can get it in abundance. Advanced seedlings up to 5 feet high, seem to be particularly liable to fungoid attacks, which sometimes seriously interfere with, or even kill the growing-point, often resulting in large excrescences of abnormal growth on the summit. If this happens, not too close to the ground, it frequently results in an outburst of reversion-foliage along a portion of the stem, or on the proximal portions of any branches that may be present. This will often supply most instructive stages in the transition from bipinnate leaves to euphyllodes, which are not shown in normal seedlings.

Eleven examples of remarkable leaves (nat. size) are shown in Plate i. These are of interest because, in addition to the ordinary apical pair of pinnæ, or this and the second pair next below it, some of them show pairs of reduced pinnæ, or single reduced pinnæ, pairs of leaflets or single leaflets, at different levels, on the margin of the developing euphyllode or half-euphyllode, instead of on the midrib; others show foliaceous terminal setæ; and two have three leaves at a node. Figs. 1, 3, and 11 have no or but slight development of the lower side of the euphyllodes. All three have an odd pinna below the first pair of pinnæ, or just below the second pair (the leaflets missing in Fig. 3); and, at a lower level, a pair of pinnæ with a reduced number of leaflets, on the margin of the euphyllode. *A. suaveolens* is remarkable in this respect, namely, for the transference of the leaf-buds to the margin of the euphyllode, instead of their remaining on the midrib.

Figs. 2 and 6 show two pairs of pinnæ (one pinna missing in Fig. 6) and a single, small pinna, with but few leaflets, on the edge of the euphyllode. They are figured especially to show, what I have seen only in the reversion-foliage of this species, in which it is common—the occurrence of three leaves at some of the nodes, of which the middle one is always the most developed. In the examples given, the two lateral leaves of the trio are simply pinnate. But, sometimes, one or both may be bipinnate; or the middle one may be a complete large euphyllode, while one, at least, of the lateral ones may be a smaller euphyllode. The two lateral leaves probably develop from reserve-buds. Lubbock describes and figures a seedling of *A. verticillata*, of which the sixth leaf was represented by a single euphyllode, but some of the succeeding ones by broken or complete whorls of euphyllodes. Other species may also have whorled or verticillate or grouped euphyllodes; but, as far as I know, nothing analogous to it is known in bipinnate Acacias. Fig. 2 shows the terminal seta; and the retarding effect of the presence of the second pair of pinnæ on the flattening of the internode, and for some distance below.

Figs. 4, 5, and 7 show a pair of leaflets, or two odd leaflets, on the margins of the euphyllode at different levels. Sometimes a pinna, or a leaflet or leaflets, may be quite close to the base, indicating that the petiolar portion of the euphyllode is relatively very short. I have two examples of nearly complete euphyllodes, one of which has an apical pair of pinnæ, and a large leaflet with an opposite pair of small ones, on the margin ⅝ inch from the base; while the other has an apical pinna with two pairs of leaflets, and a marginal pinna with two pairs of leaflets, ⅜ inch from the base. Another specimen has one pair of pinnæ, of which one has a terminal leaflet. I have one leaf with three complete pairs of pinnæ.

Figs. 4, 8, 9, 10 show foliaceous terminal setæ. Two of them have marginal leaflets, and in one case, a pinna which shrivelled in drying.

I am indebted to Mr. C. T. Musson for some very interesting reversion-shoots from a shrub of *A. podalyriaefolia*, which had been cut back. These are particularly interesting, because this species has short euphyllodes, which are nearly as broad as they are long, up to $1\frac{1}{2} \times 1\frac{3}{16}$ inches. Seventeen leaves show no flattening on the lower side, and fifteen of these have two pairs of pinnæ. Three of these are figured. (Plate vii., figs. 1-3.) They all show much flattening of the upper side of the leaf-axis up to the level of the lower pair of pinnæ, and some flattening of the internode. But the lower, broad, flattened portion has a loose end. The presence of the lower pair of pinnæ, by retarding the flattening of the internodal contribution to the complete euphyllode and blocking the way, left the portion below the lower pair of pinnæ in the lurch, in all three cases; and I have others more or less like them. Two examples, with one pair of pinnæ (Pl. vii., figs. 4-5) show very well the rudiment of the terminal pinna, without leaflets, with the terminal seta, which, in this species, unless accidentally missing, is usually conspicuous on the early euphyllodes, and particularly on the young ones. It is so long sometimes that, when dry, it twists. It is obvious that, in this case, the euphyllode comprises two, or at the most, three, internodes, and the petiole. If it were not euphyllodineous, this species would be a bipinnate Acacia with three pairs of pinnæ, occasionally, perhaps, four at the most. Cambage has recently described and figured the seedling of this species [Part v. of his papers].

The finest examples of reversion-shoots and suckers, I have yet seen, are two lots of *A. implexa* (?), which I quite casually met with in March, 1919: One lot comprises specimens from two plants, 8-10 feet high, growing close together, that had been badly scorched by a bush-fire, which killed the parts above ground, but without injury to the root-system. Reversion-shoots from the base of the stems, and suckers from some of the roots came up freely. I fortunately found them in the early stages; and specimens were taken, from time to time, over a period of six months, until what were left had only euphyllodes, or a few bipinnate leaves of no importance. The second lot was procured from some half dozen plants at the side of a country-road, which had been mischievously broken or cut off a little above the ground.

From the complete collection, I have been able to select a sequence of leaves, which include—(1) simply pinnate leaves, present on two suckers, but, if developed, missing on the reversion-shoots; (2) bipinnate leaves with from one to eleven actual or potential pairs of pinnæ, some of the lowest pairs being represented by leaflets; and (3) the five late stages of the waning pinnæ, and the waxing flattening of the long common petioles or primary leaf-axes, shown in Plate vii. The entire sequence is not shown, my main object being to show as many as possible of the best examples illustrating the inversely proportional ratio in which the two antagonists are represented at various stages. The substitution of flattening axes for pinnæ is not a case of "walk in, walk out." It is an intense struggle between them. The potentially heavyweight euphyllodes knock-out the bantam pinnæ very promptly in weak seedlings. But, in reversion-shoots, with a well-established root-system to back them up, they put up a much better fight, and are able to prolong the strnggle!, hopeless though it is.

These specimens are most interesting because the euphyllodes are so long, up to about 9 inches, and yet not too narrow. This means that, if they were not euphyllodes, they would be bipinnate leaves with numerous pairs of pinnæ, up to 15-20. Therefore, they contrast admirably with, and supplement the two cases, one with very short and the other with euphyllodes of medium length, already considered. Nevertheless, they show only another phase of the same kind of thing. The three are not special cases, but only those of which I have been able to get adequate material.

The illustrations (Plates ii.-vii.) need little explanation, if it is kept in mind:—

(1) That the succession of the pinnæ in the development of the compound. bipinnate leaves of the Australian Acacias is basipetal, not basifugal, as in the leaves of Jacaranda. In seedlings, the first leaf, or a pair of them, is simply pinnate, a simpler type of those which come after it. Then follows an abruptly bipinnate leaf with one pair of pinnæ, representing the replacement of the apical pair of leaflets of the first pinnate leaf, without any representatives of the other pairs of leaflets. That it is the apical pair, is shown by the presence of the terminal seta at the apex of the common petiole of every leaf, from start to finish, unless it is accidentally missing. Then, in due course, in the seedlings of the Bipinnatae, of some of the Euphyllodineæ, and in reversion-foliage and reversion-shoots of any of them, follow leaves with two, three, or more up to the complete number, or approximating thereto. These represent always the apical pair and one, two, three, or more pairs, as the case may be, up to the full number, of successive pairs of pinnæ, in order next below the apical pair. The apical pair is always present in every leaf, however many pairs of pinnæ may be present, except in the decadent stages of the outgoing pinnæ, as illustrated in Plate vii.

(2) Therefore, if the full possible number is not present, the shortage is in the lower portion of the series. Also, the good, well-developed pinnæ, if all of them are not equally well-developed, when a number of pairs are present, are those attached to the upper part of the common petiole; and the poor specimens, sometimes only represented by leaflets, are attached to the lower part of the leaf-axis, as is shown in figs. 1-4 of Pl. vi., and figs. 4 and 6 of Pl. vii.

(3) This provides an opening for the flattening of the axis to make a start on the proximal portion of the leaf-axis, where pinnæ are absent or poorly developed. If only one pair of pinnæ is present at the apex, the surviving apical pair, as shown by the presence of the terminal seta, the entire leaf-axis may flatten from top to bottom (Pl. iii., fig. 5; Pl. vii., fig. 4). Illustrations of flattening axes with an apical pair of pinnæ, more or less resembling my examples, are commonly shown in textbooks, as confirmation of the statement, that the so-called phyllodes of Acacias are flattened petioles which have lost their blades!

The figures of Plates iv.-v., and fig. 5 of Pl. vi., show a few pairs (2-5) of strong pinnæ attached to the upper part of the leaf-axis; well-marked flattening of the axis in the lower part; but retarded flattening where the pinnæ are situated.

though there may be unmistakable indications of it. Fig. 3 of Pl. iv., and fig. 5 of Pl. vi., show the damping effect of the presence of good pinnæ excellently.

Figs. 1-4 of Pl. vi., show the retarding influence of the presence of pinnæ on the flattening, in the leaves with the maximum number of pairs of pinnæ, that I have succeeded in finding. These are very instructive. Leaves with 7-9 pairs are not shown, only for want of space, and because they do not show anything more than these do.

Plate vii. shows the last stages of the decadent pinnæ, correlated with a maximum of flattening of the leaf-axis. Figs. 1, 2, 4 and 6, representing the pinnæ on their last legs, are the only ones of the entire series which lack the apical pair of pinnæ. Figs. 4 and 5 are particularly instructive, because they show a minimum amount of flattening in the proximal part of the leaf-axis, where the forlorn surviving pinnæ or leaflets are stranded; and then, distad of them, the flattening soon increases. Fig. 4 has but two single pinnæ with a reduced number of leaflets; unfortunately the upper portion of the euphyllode was missing when I got it. Fig. 6 shows the lowest pair, and the one next above, represented by leaflets; and then, above these, a pair of reduced pinnæ, and a distal better pair. The portion of the axis below the lowest leaflet, the real or apparent petiole, is longer than the internode above it—even allowing that it may be the real petiole—but it is relatively very short. In the face of such evidence as this, can anyone still believe that the so-called phyllodes of the Australian Acacias are merely flattened leafstalks or petioles which have lost their blades?

An interesting paper by Dr. C. E. Preston, on "Peculiar Stages of Foliage in the Genus Acacia," is contained in the American Naturalist, Vol. xxxvi., p. 727, September, 1902. This is worth attention, because what is so often tacitly assumed and taken for granted, is discussed in this paper; namely, to which pair of leaflets of the first simply pinnate leaf of a seedling does the single pair of pinnæ of the next bipinnate leaf correspond? Preston says: "A peculiar transition-stage between the singly pinnate and the bipinnate is sometimes found in seedlings of *A. leprosa* Sieber, when growing under cultivation. The shadow-prints (Figs. 1 and 2) annexed show the nature of this peculiarity. The lower pair of leaflets only is replaced by a pair of strongly developed pinnæ, while the rest of the axis runs on singly pinnate and rather weak in structure. As a rule, no such continuation of the main axis is to be found." Shadow-prints of two young seedlings are given, showing an "abnormal third leaf" in each case; the first being simply pinnate, the second bipinnate, and the third apparently tripinnate. With all due deference to the author, and simply on the basis of *magna est veritas et prevaleat*, I venture to express the opinion that, having inadequate material, he completely missed the significance of his abnormal leaves, and misinterpreted them.

From my standpoint, they are one of two things—(1) either examples of tripinnate leaves, an apical pair together with a terminal pinna (the middle one); or, what is more probable, a complete, apical pair (the middle one, and one of the lateral ones), and an incomplete pair next below (the other lateral one, its fellow, missing), the internode which should have separated the pairs (complete or incomplete) not having lengthened. One cannot decide which view is correct, because the terminal seta is not mentioned; and it is not recognisable in the small shadow-prints. In both cases, the stalk below the three pinnæ is the common petiole or primary leaf-axis, and not the petiole only, as the author supposes; as is suggested by the length of it.

Cambage has examined seedlings of more species than any other writer; descriptions and illustrations of fifty-five have already been published. He has not so far found a leaf of a seedling with the terminal pinna present, but he has met with one instance of it in the leaf of a sucker. I have had the opportunity of looking over several thousand wild seedlings, representing about twelve species, in the hope of finding anomalies, but with little success. I have not yet seen a leaf of any Acacia, seedling or adult, which had a complete terminal pinna; but a leafless thread-like representative of its axis, with a terminal seta, is sometimes to be found in the leaves of reversion-shoots (Pl. iii., figs 5, 6; Pl. viii., figs. 5-6). I have also one bipinnate leaf of a seedling, of which one pinna has a terminal leaflet. *A. leprosa* is an Australian species, but no other descriptions of seedlings have been published. If the leaves of Preston's two seedlings really represent tripinnate leaves (that is the apical pair, together with a terminal pinna), they are, as yet, the first to be recorded.

What I believe to be the correct explanation of them is, that they are merely examples like the three shown in my Pl. iii., fig. 3; and Pl. viii., figs. 9-10. The first of these is the leaf of a reversion-shoot. I have others like it; and others with the two pairs complete, but separated by a very short internode. The second is a leaf of a seedling of *A. myrtifolia*, and the only specimen I have. But Cambage has figured similar leaves of *A. buxifolia* and *A. pycnantha* [Acacia Seedlings, Part iii., p. 393]. When the terminal seta is taken account of, there is no difficulty in interpreting them. The third is a leaf of *A. decurrens*, which is comparable with the others.

I have failed to find any evidence whatever that the lowest or proximal pair of leaflets of the first simply pinnate leaf is ever replaced by a pair of strongly developed pinnæ, while the rest of the axis runs on simply pinnate, and rather weak in structure. On the contrary, the apical pair of leaflets is replaced by an apical pair of pinnæ; and there is no replacement at all of the lower leaflets of the first pinnate leaf before the transition of complete euphyllodes in seedlings of many species, though there is in others, as in the Bipinnatæ. Therefore, in every leaf, at every stage of development, whatever else may be present or absent, the apical pair is normally present, and, in the very early stages, it is the only pair. The succession of the pinnæ in the development of the bipinnate leaf is basipetal.

The leaf of *A. decurrens* figured by Preston as "showing a tendency towards a triple pinnation," that is, "showing clearly the third degree on some of the basal leaflets of the pinnæ," is a remarkable but rare aberration. This species is a very common one in the Sydney district, and I have examined many leaves; but I have not succeeded in finding specimens of this or any other Acacia which show it. But I have collected three leaves of Jacaranda, which have a few of the basal leaflets of the lowest pinnæ exemplifying a tendency toward a triple pinnation.

But what Preston has to say about the leaves of *A. heterophylla*, of which he gives illustrations, is very important. This is a species indigenous to the Island of Bourbon and Mauritius, or both of them, I believe; and I cannot hear that it is cultivated in Sydney gardens. It is sometimes mentioned in textbooks, and it appears to be a remarkable species, like *A. melanoxylon*, *A. rubida*, and perhaps some others, all of which are worthy of a detailed study of gradational series of plants of various ages. Preston says—"There was also found a fairly large number of stages [of *A. heterophylla*] which lead one to doubt greatly whether in all cases it is the petiole only which is transformed to the phyllode, and pinnæ. They illustrate very well the inversely proportional ratio in which the proximal one. The prints which follow may, to be sure, represent mere anomalies, but from their number, at least, they cannot but raise in one's mind a certain hesitation to consider the existence of a law as to method in any way established.

Here the flattening appears in some cases entirely on the distal portions without affecting the petiole, in others both petiole and rhachis are involved to varied extents. How these are to be interpreted under one general law seems incomprehensible."

Preston does not say whether the seven leaves figured are such as are to be found on ordinary plants, whose growth has not been interfered with by pruning or otherwise. In the absence of descriptions of the plants or of seedlings, and of personal knowledge of the species, or of any other like it, I cannot settle the point. But they are certainly comparable with some of the leaves of reversion-shoots, as shown in my Plates, especially Pl. iii.-vi. They are pictures of the contest between the flattening common petioles, or leaf-axes, and the pairs of pinnæ. They illustrate very well the inversely proportional ratio in which the two antagonists are present in any particular leaf; and how, if pinnæ are present, no matter where they may be located, the flattening of the leaf-axis is retarded where they are situated; and how, if they are absent on some part of the axis, no matter where, the flattening of the axis is correspondingly favoured in that particular region. The localised damping or retarding effect of the presence of the pinnæ on the flattening of the leaf-axis is very well shown in some of his figures.

But the idea that the so-called phyllodes of some Acacias are flattened petioles which have lost their blades, and of others, that they are flattened axes which have lost their pinnæ, is erroneous. There are not two kinds of phyllodes, so-called, of Acacias. The two hypotheses, that there are, cannot be harmonised. Therefore, I am prepared to go further than Preston, and say that the attempt to interpret them under one definite law not only seems, but is, incomprehensible, inasmuch as it is not possible. The so-called phyllodes of Australian Acacias are not flattened petioles which have lost their blades, as both seedlings, when they are correctly interpreted, and reversion-foliage and reversion-shoots demonstrate. Therefore, they have been improperly called phyllodes; and consequently any attempt to interpret them in terms of something which they are not, cannot but be futile. But when it is realised that the euphyllodes of all the Acacias of which we have sufficient knowledge, are flattened leaf-axes or common petioles, which have lost their pinnæ, then it becomes possible to say, that there is but one definite law which applies to all that are known, and that it is a readily comprehensible law.

I regret that I am unable to consult Reinke's paper,* referred to by Preston. It is not available in Sydney. The abstract of it in the Journal of the Royal Microscopical Society (1897, p. 549) does not include Reinke's views about phyllodes. Under the circumstances, Preston supplies what one chiefly wants to know, namely—"*A. rubida* A. Cunn. and *A. heterophylla* Willd., have already been described by Reinke, and in his article one stage in the transition as it occurs in *A. heterophylla* is figured. According to that author, the change is merely a gradual flattening of the petiole, accompanied by the reduction of parts more distal." It is not surprising that Preston was unable to reconcile the views here stated, with the characteristics of the leaves which he figures.

Goebel, in his "Organography of Plants" (Vol. i., p. 166, fig. 102) remarks—"The best known and most frequently quoted are the species of Acacia which produce phyllodes. The phyllodes arise by the broadening in a vertical direction of the leaf-stalk, sometimes also of the leaf-midrib, whilst the lamina aborts. Seedling plants (Fig. 102), however, have, without exception, so far as they have been examined, leaves which are like those of the species—possessing a bipinnate

* Reinke, J., "Untersuchungen über die Assimilationsorgane der Leguminosen." Pringsheim's Jahrb. f. wiss. Bot. Bd. xxx., 1896.

lamina and a normal leaf-stalk. As successive leaves are formed, the leaf-stalk gradually broadens, whilst the lamina is reduced until the form of the phyllode is attained. In some species foliage-leaves may again appear after the phyllodes, for instance in *A. heterophylla*."

Also, in Vol. ii., p. 355 he adds—"The best examples of the formation of phyllodes are to be found in a number of Australian species of Acacia." It is usually said that in the phyllode of Acacia the lamina is entirely wanting. This is incorrect, for the lamina can always be seen upon the primordium. . . . In some species, for example *A. floribunda, A. melanoxylon,* and *A. uncinata,* there are transition-forms which show that the rhachis may have a share in the formation of the phyllode."

Inadequate material, and the disregard of the presence, the meaning, and the significance of the terminal seta, as in so many other cases, are herein responsible for the misinterpretation of seedlings. What Goebel calls the primordium of the lamina, which is always present upon the phyllode, I should term the terminal seta merely, or sometimes, in the young or early euphyllodes (but not in late ones), juvenile stages of a pair of pinnæ, always the apical pair, together with the terminal seta, at the apex of the flattened common petiole. His suspicion that, in some species, the so-called phyllodes are something more than flattened leaf-stalks, is interesting. I regret that I have not been able to make more use of Goebel's important treatise. I have been unable to purchase or borrow it; and there are so few copies in Sydney, that one can consult them only under time-consuming conditions.

EXPLANATION OF PLATES i.-viii.

REFERENCE LETTERS.

a. t. p., leafless, thread-like axis of the terminal pinna—*f. t. s.*, foliaceous terminal seta—*t. p.*, terminal pinna—*t. s.*, terminal seta

Plate i.—*A. suaveolens* (reversion-foliage).

Figs. 1-7 and 11 show leaves with two pairs or one pair of good pinnæ on the upper part of the common petiole or primary leaf-axis; and poorer pinnæ with a reduced number of leaflets, or a pair of leaflets or odd leaflets *on the margin* of the lower part of the flattening leaf-axis below the second good pair (when there are two pairs), that is, on the developing half-euphyllode (the flattening on the upper side of the axis only), or euphyllode. Note the inversely proportional ratio in which the two antagonists are present.

Figs. 2 and 6 show also three leaves at a node, the two lateral ones simply pinnate.

Figs. 4, 7, 9, 10 show green, foliaceous, terminal setæ.

Plate ii.—*A. implexa* (?).

Fig. 1—An average complete euphyllode.

Fig. 2.—A seedling showing the transition from a bipinnate leaf with one pair of pinnæ (the apical pair) to a complete euphyllode on the fifth leaf. The fourth leaf is a portrait of the two juvenile antagonists—a pair of pinnæ (bantam), and the leaf-axis or common petiole to which they are attached (the potential heavy-weight, which, after the tussle is all over, attains the dimensions of the example shown in Fig. 1).

Plate iii.

Fif. 1.—Upper portion of a leaf of *Caesalpinia Gilliesii* to show the terminal pinna present in this species. This, in the Acacias, aborts, and is represented by a remnant, the terminal seta.

Fig. 2.—Leaf of a seedling of *A. discolor*, showing the basipetal, incomplete developments of the leaflets of the middle pair.

Figs 3-6.—Leaves of Reversion-shoots of *A. implexa* (?).

Fig. 3.—Back view of a leaf with what appears to be a terminal pinna. The middle one and the one on the right constitute the apical pair, as indicated by the presence of the terminal seta (discernible with a lens in the photo). The one on the left, whose fellow did not develop, represents an incomplete second pair next below, very close to the apical pair because the internode did not lengthen.

Fig. 4.—Leaf with one pinna of the second pair missing. Two alternate, or perhaps odd pinnæ below, represented by large leaflets.

Fig. 5.—Leaf with the apical pair of pinnæ only, and a terminal pinna represented by a leafless thread-like axis, and a terminal seta. The whole of the axis is more or less flattened.

Fig. 6.—Another leaf with three pairs of good pinnæ, and a rudimentary, leafless, terminal pinna, and a terminal seta. Some flattening of the axis throughout, but retarded where the pinnæ are.

Plate iv.

Fig. 1.—Complete leaf (back view) of *A. Baileyana*, with four pairs of pinnæ, and a terminal seta, visible with a lens. Note the excessively short petiole.

Figs. 2.—Leaves of reversion-shoots of *A. implexa*, including two complete euphyllodes. The branchlet shows the order of the succession. Note the inversely proportional ratio in which the two antagonists are present—good pinnæ on the upper part of the axis; much flattening on the lower part, extending upwards, but retarded where the pinna are (especially in Fig. 3). Also the terminal seta at the tip of the larger phyllode; rudimentary pinnæ in the smaller one.

Plate v.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 1-5.—Most interesting stages of the contest when the antagonists are fairly equally matched. Good pinnæ on the upper part of the axis; flattening most marked on the lower part, extending upwards, but retarded where the pinnæ are. Note the terminal setæ, with some indication of the developing pinnæ of the apical pair in the youngest euphyllodes, and the terminal seta alone in the largest one.

Plate vi.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 5-6 supplement the series shown in Plate v., and are fine specimens.

Figs. 1-3, with 11 and 10 pairs of pinnæ, the maximum number, as yet seen, show the pinnæ doing their very best. Some of the lowest pinnæ show reduction in the number of leaflets. The lowest pinnæ in all three are represented by leaflets. The presence of so many pinnæ has obviously put the brake on the flattening of the axes. Note the short petiole in Fig. 3, and the terminal seta in Fig. 5. Also, that, in the leaves of this species, the pinnæ are attached to the midrib, and not to the margin, as in *A. suaveolens* (Pl. i.).

Plate vii.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 1-7. Six decadent stages of the waning pinnæ, variously located, and a complete euphyllode. The common petioles or primary leaf-axes show more or less flattening from base to apex. The distal portion of No. 4 is missing; but note the retardation of the flattening in the lower portion of this and No. 6, where the reduced pinnæ, or leaflets are; and how the flattening increases distad of the distal pinna or pair of them. Note also the short petiolar portion of No. 6, in which the two proximal pairs of pinnæ are represented by leaflets.

Plate viii.

Figs. 1-4.—Four, developing half-euphyllodes of *A. podalyriaefolia* with two pairs of pinnæ; some flattening of the internode; and the broad flap-like flattening of the axis below the second pair of pinnæ, with a loose end, which, but for the presence of the lower pair of pinnæ, would be joined up with the apex by the fully flattened, internodal portion.

Figs. 5-7.—One half-phyllode, and one nearly complete, with one pair of pinnæ, and a rudimentary, leafless, terminal pinna and terminal seta, of the same species.

Fig. 7.—Young euphyllodes of the same species, showing the conspicuous terminal setæ.

Fig. 8.—Three very young leaves of *A. discolor*, showing the terminal setæ of both the rhachis, and of the partial rhachises.

Fig. 9.—Upper portion of seedling of *A. myrtifolia* with the fifth leaf apparently tripinnate. The middle one and the one on the right, with the terminal seta between but behind them, are the apical pair. The one on the left represents an incomplete second pair next below, the internode not having lengthened.

Fig. 10.—Upper portion of a leaf of *A. decurrens*, showing the same sort of thing, the middle pinna and the one on the left being the apical pair. The rest of the leaf, together with eight pairs of pinnæ have been removed.

Fig. 11.—Upper portion of a not mature remarkable leaf of *Jacaranda* (the rest of the leaf, with eleven pairs of pinnæ having been removed), showing four pairs of pinnæ towards the apex, and the terminal pinna, all represented by leaflets, some with serrated edges; and the pinnæ with terminal leaflets.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1919, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that it be received and adopted, which was carried unanimously.

No valid nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

PRESIDENT: Mr. J. J. Fletcher, M.A., B.Sc.

MEMBERS OF COUNCIL (to fill six vacancies):—Messrs. J. E. Carne, F.G.S., H. J. Carter, B.A., F.E.S., Prof. T. W. E. David, C.M.G., D.S.O., D.Sc., F.R.S., Prof. W. A. Haswell, M.A., D.Sc., A. H. S. Lucas, M.A., B.Sc., and J. H. Maiden, I.S.O., F.R.S.

AUDITOR: Mr. F. H. Rayment, F.C.P.A.

It was resolved, on the motion of Miss S. Hynes, seconded by Mr. A. G. Hamilton, "that it is the opinion of Members of this Society that in the interests of Science, the Rowan Collection of paintings should be retained in this the Mother State."

On the motion of Mr. A. G. Hamilton, a very cordial vote of thanks to the retiring President, Mr. J. J. Fletcher, was carried by acclamation.